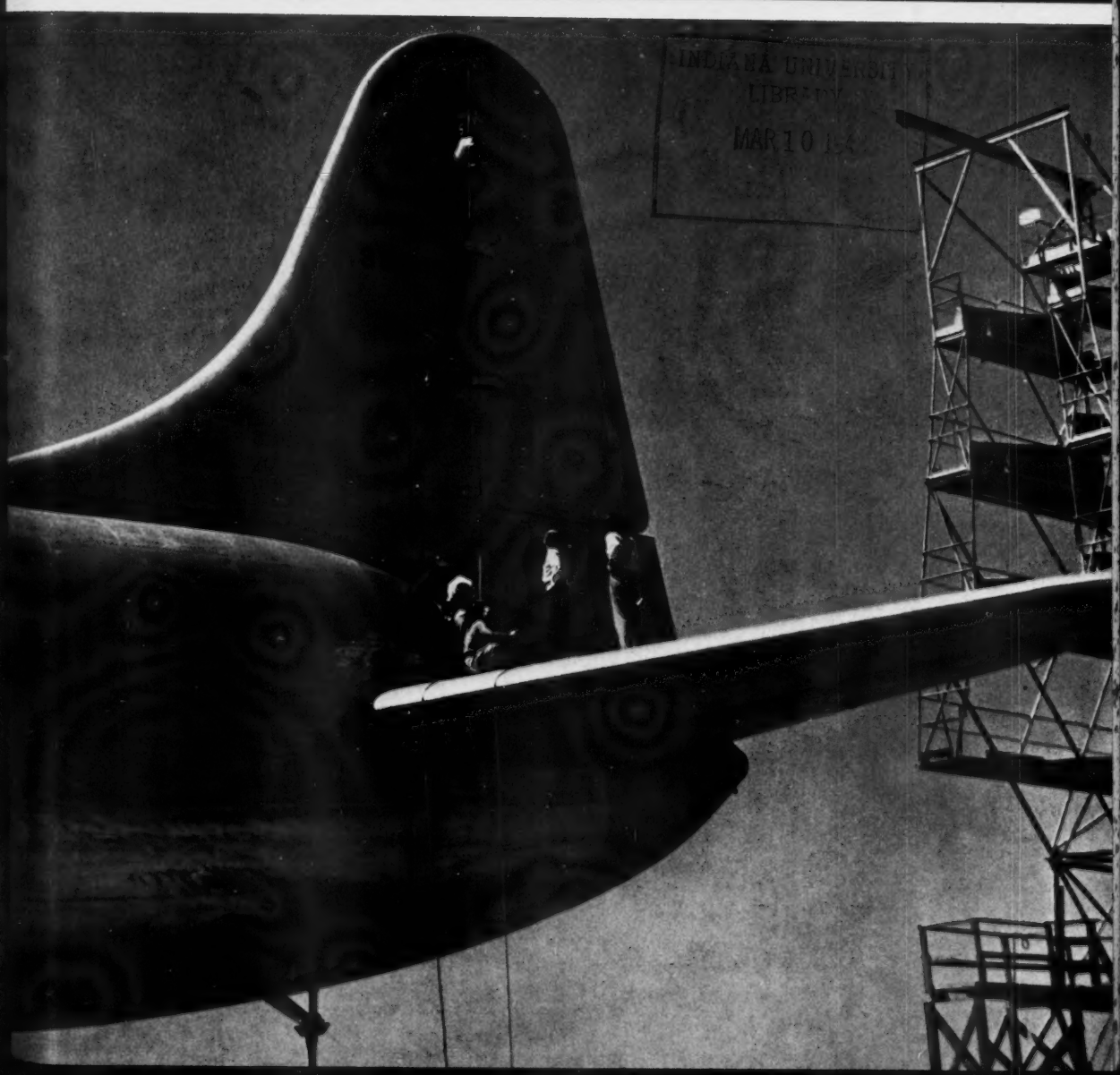
AERONAUTICAL ENGINEERING REVIEW

FEBRUARY 1948



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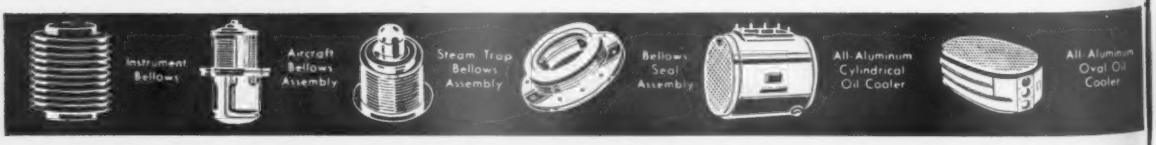

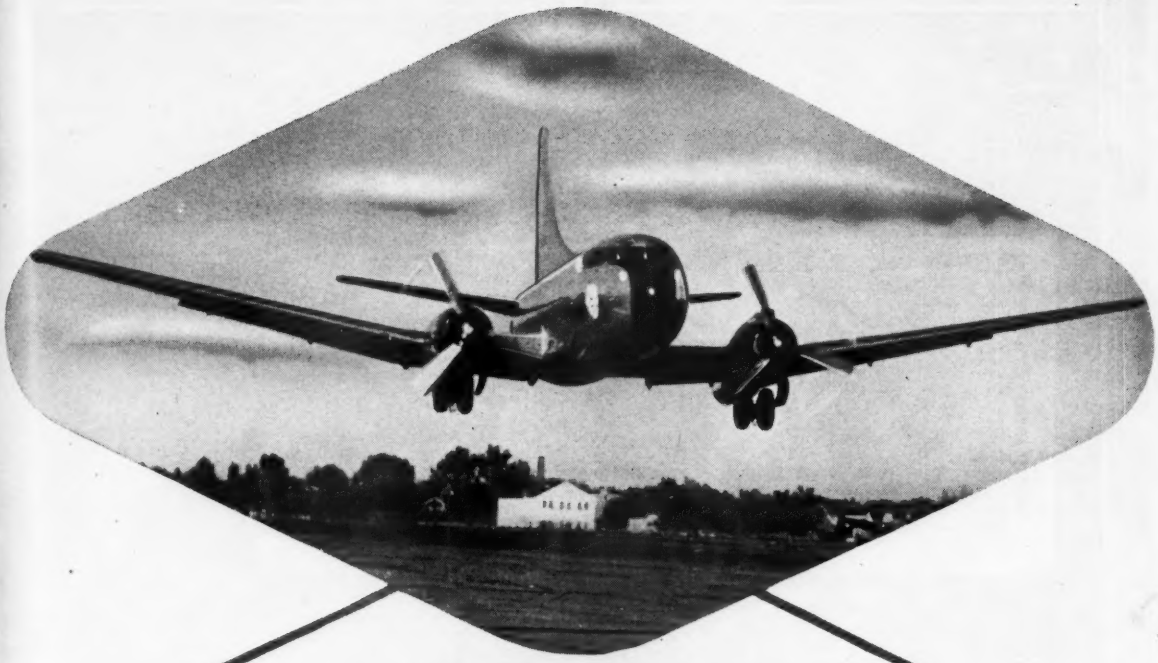

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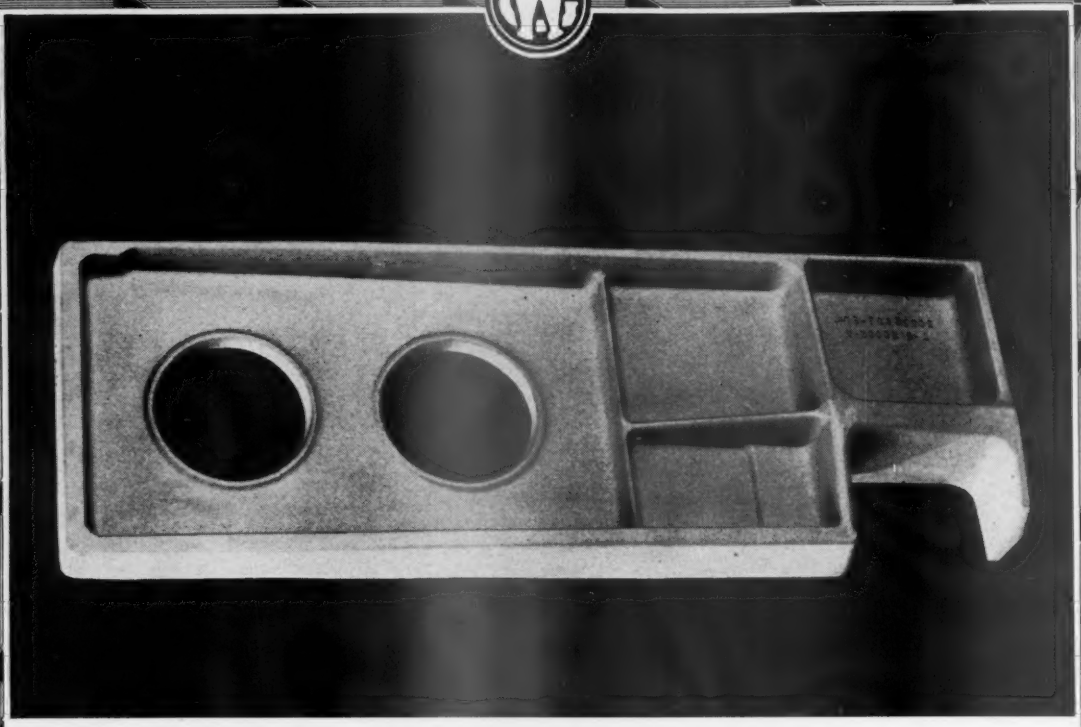

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Cover—Tail section of the Air Force's gigantic XC-99 Convair transport.

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AERONAUTICAL ENGINEERING REVIEW

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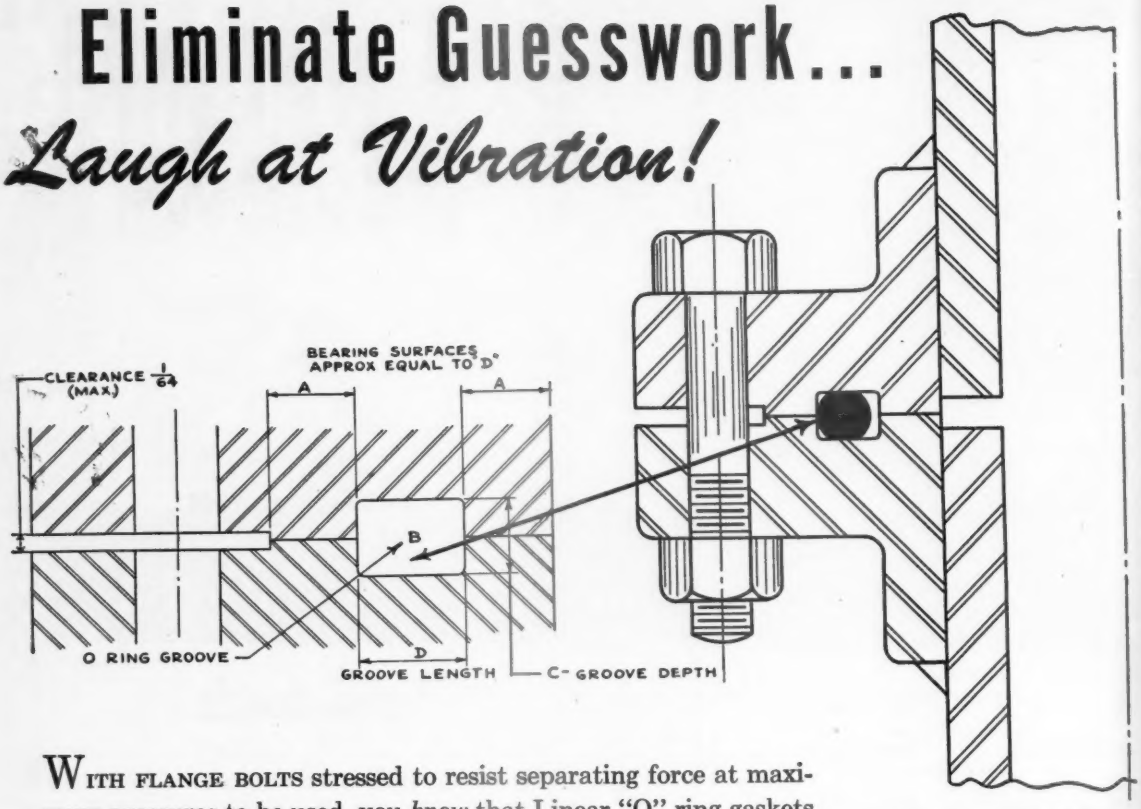

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I.A.S. News

A Record of People and Events of Interest to Institute Members

Propulsion Meeting Date Advanced; To Be Held March 19 in Cleveland

Tentative Program for Morning, Afternoon, and Evening Calls for Sessions Devoted to the Gas-Turbine Engine, Engine Installation Problems, Further Improvement of Turbine Propulsion Systems, by Engine, Aircraft, and N.A.C.A. Engineers, Respectively.

Cleveland Host: *Abe Silverstein, Chairman of Cleveland I.A.S. Section, will be host at Flight Propulsion Meeting in Cleveland next March 19.*

BECAUSE OF THE early Easter holiday this year, date for the Third National Flight Propulsion Meeting in Cleveland has been set forward from March 26, as originally planned, to March 19. Place of the meeting, the Hotel Carter Rainbow Room, remains the same.

Tentative program planned as we go to press divides the technical sessions into three parts: Gas-Turbine Problems; Design Problems of Turbojet Power-Plant Installations; and Performance Possibilities of Turbine Propulsion Systems.

Engine manufacturers and university personnel have been invited to give papers in the morning session on gas-turbine problems. For the afternoon technical session, speakers from prominent aircraft manufacturers have been selected to cover design problems in the application of power plants to high-speed aircraft. The final session will have four speakers from the Flight Propulsion Research Laboratory of the National Advisory Committee for Aeronautics.

The suggested program is as follows:

▸ **Morning Session**—Following registration at 9 a.m., the morning technical session on Gas-Turbine Engine Problems would open at 9:30. It is planned to have four papers, the session to end at noon.

Chairman of the session will be E. S. Thompson, Manager, Aircraft Gas Turbine Division, General Electric Company.

Luncheon at 12:30 p.m. in the Rainbow Room Terrace will feature a prominent guest speaker.

▸ **Afternoon Session**—As the technical session in the afternoon is planned to be short—2 p.m. to 4:30—each of the four speakers will be allotted approximately 20 min., followed by a round-table discussion under the direction of a moderator.

Dinner is scheduled for 6:30 p.m. Because of the full program planned, no dinner speaker is to be selected.

▸ **Evening Session**—Subjects of papers for the final session are expected to concern compound engines; gas generator engines; turboprop and turbojet engines, which will be presented by N.A.C.A. Flight Propulsion Research scientists. Abe Silverstein, Chief, Wind Tunnel Flight Division, Flight Propulsion Research Laboratory, N.A.C.A., will chairman the session.

Abe Silverstein, Chairman of the Cleveland Section and host for the meeting; Gene Wasielewski, Chairman of the Program Committee and Vice-Chairman of the Section; and Willson H. Hunter, Past-Chairman of the Section and member of the Program Committee, are working out the details of the meeting and program.

▸ **Luncheon and Dinner Tickets**—Tickets for the Luncheon are $2.50; Dinner tickets, $3.75. Prices include gratuities. Tickets may be obtained from the Institute of the Aeronautical Sciences, 2 East 64th Street, New York 21, N.Y.

The meeting is open to members, but a registration fee of $1.00 will be charged nonmembers.

A program with complete details will have been mailed to all I.A.S. members by the time this announcement is read.

I.A.S. Calendar

March 19	Flight Propulsion Meeting, Cleveland
July 15–16	Annual Summer Meeting, Los Angeles

For details see page 30

I.A.S. Awards and

Lawrence A. Clousing, Head of Flight Section, Ames Aeronautical Laboratory, N.A.C.A.

The Octave Chanute Award

For a notable contribution made by a pilot to the aeronautical sciences.

This award was established by the Institute in 1939 to honor the memory of Octave Chanute, pioneer American aeronautical investigator, who died in 1910.

Presented to LAWRENCE A. CLOUSING

"For research on airplanes at high speeds, enabling measurement of compressibility effects on stability, control, and structural loads at high Mach Numbers."

In the last year, Mr. Clousing carried out research on various airplanes at very high Mach Numbers, well in excess of those previously attained in flight. He was able to measure compressibility effects on stability, control, and structural loads at Mach Numbers greater than 0.85. Mr. Clousing's research is expected to have profound effect on the design of high-speed aircraft.

Educated at University of Minnesota, he received his M.S. (Ae. E.) in 1933. In 1926 he had learned to fly and received commercial pilot certificate number 6103. He was Instructor of Mechanical and Aeronautical Engineering, School of Engineering, Northwestern University from 1933–1937. In the Naval Reserve since 1926, Mr. Clousing was promoted to the rank of Lieutenant Commander in the Naval Air Reserve.

He was appointed engineer and test pilot at N.A.C.A.'s Langley Field, Va., in 1938 and subsequently was promoted to his present position at the Ames Aeronautical Laboratory.

Air Commodore J. W. Tice, R.C.A.F., Consultant in Aviation Medicine, R.C.A.F.

The John Jeffries Award

Honoring the memory of Dr. John Jeffries, an American physician who, with Blanchard, the French balloonist, made the first aerial voyage across the English Channel in 1785 and on a previous voyage made the earliest recorded scientific observation from the air, this award was established by the Institute in 1940 to give recognition to the importance to aviation of scientific endeavor in the field of medicine.

Presented to J. WINFRED TICE, M.D.

"For outstanding contributions to the advancement of aeronautics through medical research."

During World War II, Dr. Tice served in the Royal Canadian Air Force, being appointed Director of Medical Services in February, 1943, with the rank of Air Commodore. In the R.C.A.F., he devised a plan and wrote a book on a medical system that was later adopted and used throughout the war. In addition, Dr. Tice developed the procedure for selecting air-crew personnel and set up medical selection boards; helped organize medical establishments and hospital organizations of various air force commands; was instrumental in bringing about a change in the scale of rations provided to airmen and officers; and helped to develop a method of reconstitution of powdered milk which was popular among men in isolated stations.

A graduate of the University of Toronto, June, 1921 (M.B., Toronto), Dr. Tice is a certified specialist in Internal Medicine, Royal College of Physicians and Surgeons (Canada), 1944; a Fellow, American College of Physicians; and a Fellow in Aviation Medicine, Aero Medical Association, of which he is the 1947–1948 President.

Col. Benjamin G. Holzman, Office of the Deputy Chief of Air Staff for Research and Development.

The Robert M. Losey Award

Established in 1940, this award honors the memory of Capt. Robert Moffatt Losey, a member of the Institute and a meteorologic officer of the Air Corps, who was killed at Dombas, Norway, April 21, 1940, while serving as an official observer for the U.S. Army. He was the first officer in the service of the United States to die in World War II.

Presented to COL. BENJAMIN G. HOLZMAN, U.S.A.F.

"In recognition of outstanding contributions to the science of meteorology as applied to aeronautics."

Colonel Holzman received his meteorological education at the California Institute of Technology, which awarded him the degree of Master of Science of Meteorology in 1938. During that period he also was Meteorologist for Eastern Air Lines (1934–1935); Meteorologist in Charge, American Airlines (1935–1936); Assistant Meteorologist, U.S. Department of Agriculture (1936–1937); and Teaching Fellow, California Institute of Technology (1937–1938). From 1938–1940 he was Associate Meteorologist, U.S. Department of Agriculture, and Supervising Forecaster, U.S. Weather Bureau, at La Guardia Field in 1940.

During the war, Colonel Holzman served as Senior Forecaster for the U.S. Strategic Air Forces and had important responsibilities of a meteorological nature in connection with the bombing and invasion of Europe.

Shortly after the close of the war, he was assigned to handle the meteorological problems connected with the Bikini atomic bomb experiments. His professional and technical accomplishments on this assignment gained him wide recognition from the Army and Navy personnel who were in charge of the experiment.

Honors for 1947

In his present position, Colonel Holzman not only has continued to make important contributions himself but also has initiated and guided many important meteorological investigations and had an important part in the successful formulation of the joint Weather Bureau, Army, Navy, and National Advisory Committee for Aeronautics Thunderstorm Project.

The Sylvanus Albert Reed Award

For a notable contribution to the aeronautical sciences resulting from experimental or theoretical investigations, the beneficial influence of which on the development of practical aeronautics is apparent.

The late Dr. S. A. Reed, designer of metal aircraft propellers and a Founder Member of the Institute, made an endowment to the Institute in 1933 to provide an annual award with a certificate and honorarium of two hundred fifty dollars. The recipient of this award is chosen by ballot of the American Honorary Fellows and Fellows of the Institute, who now number over a hundred of this country's leading aeronautical scientists.

Presented to

GALEN B. SCHUBAUER

and

HAROLD K. SKRAMSTAD

"For their contributions to the understanding of the mechanism of transition from laminar to turbulent flow."

Both Dr. Schubauer and Dr. Skramstad have made important contributions to the art of measuring turbulence and the study of boundary-layer flow.

Dr. Schubauer developed hot-wire instruments of improved reliability and ruggedness and succeeded in making measurements at a Mach Number of 1.6. He developed a method of measuring turbulence based on thermal diffusion and has made careful and accurate measurements of the velocity in a separating laminar boundary layer. These measurements have become so standard for the testing of theories that an elliptical cylinder of the dimensions used by Dr. Schubauer is commonly described as "Schubauer's Ellipse."

Dr. Schubauer received his A.B. degree from The Pennsylvania State College in 1928, M.S. from California Institute of Technology in 1930, and Ph.D. from The John Hopkins University in 1934. He was made Chief of the Aerodynamics Section of the Bureau of Standards in 1946, having previously been in the Electrical Division from 1929 to 1930.

Dr. Skramstad devised a simple method for direct measurement of the turbulent shear stress and also developed a theory of the errors due to the finite length of the wires used in hot-wire measurements.

He was graduated from the College of Puget Sound, Tacoma, Wash., with the B.S. degree in 1930 and received his Ph.D. at the University of Washington in 1935.

Dr. Skramstad then joined the staff of the Aerodynamics Section where he was engaged in the study of wind-tunnel turbulence and of the stability of laminar boundary layers. During the war he worked on the development of guided missiles and played a key part in the development of the "Bat," first fully automatic guided missile to be used successfully in combat by any nation. Subsequently, he was made Chief of the Guided Missiles Section of the Bureau of Standards.

The Lawrence Sperry Award

For a notable contribution made by a young man to the advancement of aeronautics.

This award was endowed in 1936 by the sister and brothers of the late Lawrence Sperry, pioneer aviator and inventor who died in 1923 at the age of 31. It provides an annual certificate of citation and honorarium of two hundred and fifty dollars to the recipient selected by the Board of Award.

Presented to COMDR. NOEL A. M. GAYLER, U.S.N.

"For outstanding contributions to synthetic training methods and devices in the field of aviation."

Born in Birmingham, Ala., December 25, 1914, Commander Gayler attended the West Point Preparatory School, Schofield Barracks, Hawaii, before his appointment to the U.S. Naval Academy, Annapolis, Md., by President Herbert Hoover in 1931. Graduated with credit and commissioned Ensign in June, 1935, he served on the U.S.S. "Maryland," U.S.S. "Maury," and U.S.S. "Craven."

In April, 1940, Commander Gayler took flight training at the Naval Air Station at Pensacola, Fla. He served on the aircraft carrier "Saratoga," later the "Lexington," until June, 1942.

From June, 1942, until June, 1943, Commander Gayler was assigned to duty at the Naval Air Station, Anacostia, D.C., and after duty at Patuxent River, Md., he assumed command of Fighting Squadron 12 in April, 1944.

In November, 1945, he was assigned duty in connection with fitting out Night Carrier Air Group 91 and January, 1946, was ordered to Sands Point, Port Washington, N.Y., for duty in the Special Devices Division, Office of Research and Inventions, now known as the Special Devices Center.

The synthetic training methods and devices Commander Gayler has fostered concern supersonic aircraft; carrier landings, particularly night landings; and gunnery practice for air-to-air combat and ground strafing.

Galen B. Schubauer, Chief, Aerodynamics Section, National Bureau of Standards.

Harold K. Skramstad, Chief, Guided Missiles Section, National Bureau of Standards.

Comdr. Noel A. M. Gayler, Executive Director, Special Devices Center, Sands Point.

1947 I.A.S. Fellows

Ira H. Abbott, Assistant Chief of Research, Langley Memorial Aeronautical Laboratory, N.A.C.A.

C. F. Baker, Chief Engineer, Hamilton Standard Propellers Division, United Aircraft Corporation.

Carlton Kemper, Executive Engineer, Flight Propulsion Research Laboratory, N.A.C.A.

Arnold M. Kuethe, Professor of Aerodynamics, University of Michigan.

F. A. Louden, Head of Aerodynamics and Hydrodynamics Branch, Bureau of Aeronautics, Navy Department.

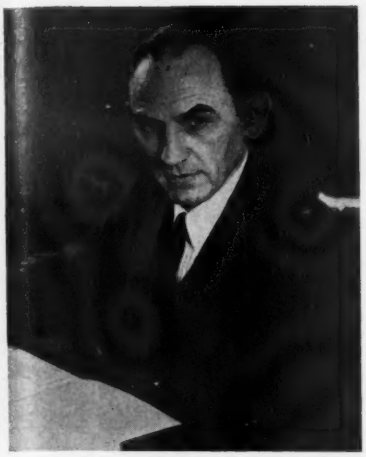
W. G. Lundquist, Chief Engineer, Wright Aeronautical Corporation.

J. S. McDonnell, President, McDonnell Aircraft Corporation.

L. B. Richardson, Vice-President, Curtiss-Wright Corporation.

W. R. Sears, Director, Cornell University Graduate School of Aeronautical Engineering.

Robert M. Stanley, Chief Engineer, Bell Aircraft Corporation.



William K. Ebel, a Fellow of the Institute, whose appointment as Director of Engineering, Curtiss-Wright Corporation, Airplane Division, was announced January 20. He joins Curtiss-Wright March 1, after more than 25 years with The Glenn L. Martin Company, where he was Vice-President in Charge of Engineering.

Three Months' S.A.I. Activity Reveals Abundant Legwork

During the three months of October through December, 1947, in which the staff of Standard Aeronautical Index was occupied in completing the finalization of Division Headings and concentrating on the coordination of Section Headings for the high priority divisions of the Index, a notable amount of legwork was involved in making personal contacts to forward the project.

In the three months' period, conferences were arranged involving a total of 278 persons connected with 55 companies, six Government agencies, and nine educational institutions covering the East, Mid-West and the West Coast. In addition, special conferences were held at the Institute and the Director, Leslie E. Neville, attended meetings of the American Standards Association Committee on Standardization of Letter Symbols and Abbreviations for Science and Engineering and the National Advisory Committee for Aeronautics and made miscellaneous personal contacts.

The Dayton Representative of the Index, Ned M. Thorne, made trips to aircraft industries and technical schools in the Cleveland-Toledo area, in addition to trips to Akron, Columbus, and Middletown, Ohio.

William L. Lewis, S.A.I. West Coast Representative, completed an exceptionally large number of visits in the Los Angeles area of the aircraft industry, including colleges and accessory manufacturers. This area is becoming a particularly active proving ground for the Index, and several company and college libraries are setting up the Divisions and Section Headings of the Index for actual use.

That the Index project is receiving world-wide attention is indicated by a request for information from the Aeronautical Research Institute of Sweden. The Acting Director of the Swedish Institute, in asking for the information on the Index, notice of which he had read in the June number of the REVIEW, called the project a "very important undertaking."

As a result of the international publicity for S.A.I., other requests for information are coming in from abroad, most recent from Hindustan Aircraft, Ltd., Bangalore, India.

Medal of Merit to Loening for Wartime Aviation Services

The President's Medal for Merit for his work in aviation in World War II was presented to Grover Loening, consulting aeronautical engineer and Fellow of the Institute, in Washington on January 12.

Presentation of the medal was by Gen. Carl Spaatz, Air Force Chief of Staff, in a ceremony at which the Secretary of the Air Force, W. Stuart Symington, was among those present.

▶ **Adviser to WPB**—Loening, who was cited for "exceptionally meritorious conduct in the performance of outstanding services to the United States from May 1942 to May 1945," was adviser on aircraft to the Chairman of the War Production Board and was also Chairman of the Helicopter Committee of the N.A.C.A. He is Chairman of Roosevelt Field, Inc.

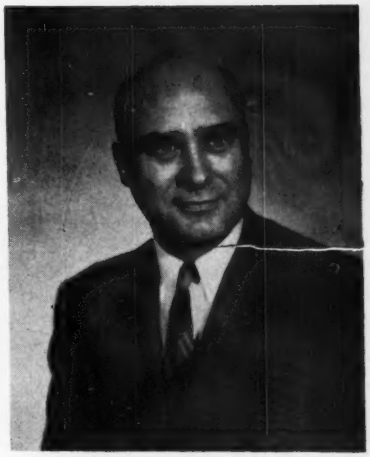
The citation further declared that he "brought with him out of his long and profound experience as an aeronautical engineer, aircraft manufacturer, and flier concepts of military aviation which were of great assistance to the prosecution of the war effort."

Journal Price Increase to Nonmembers of I.A.S.

Effective January 1, the subscription price to the JOURNAL OF THE AERONAUTICAL SCIENCES was raised from $7.00 to $12 per year for nonmember subscribers. This action does not affect Institute members, who may still obtain the magazine at the previous subscription rate of $3.50 annually.

In formulating this change in subscription policy, the general practices of other engineering societies were taken into consideration, as well as the increased printing and production costs that made the price rise mandatory.

The size of the JOURNAL has been increased from 56 to 64 pages monthly to allow for a wider coverage of the many important technical developments now taking place in the industry. It is felt that Institute members will thus benefit from the new policy in several different ways.



D. Roy Shoults, an Associate Fellow of the Institute, has been named Vice-President in Charge of Engineering for The Glenn L. Martin Company, succeeding William K. Ebel. Mr. Shoults, formerly Vice-President in Charge of Engineering for the Bell Aircraft Corporation, has been Chief Engineer at Martin since June 16, 1947.

Gifts to the Institute Collections

J. P. V. Heinmeuller added an album of transatlantic flight covers and an album of Philippine Island flight covers to the large collections he had previously given. The Texas Company, through the courtesy of M. P. Doss, gave a number of *N.A.C.A. Wartime Reports*. The Eclipse-Pioneer Division of Bendix Aviation Corporation, through the courtesy of Miss Mildred M. Baker, added aviation periodicals to its previous generous gifts. Dr. Otto Kallir added catalogs and periodicals to his previous gifts of air-mail material.

The David Taylor Model Basin sent reports and translations, adding to its previous gifts. Mrs. Bella C. Landauer continued her previous gifts with magazine clippings. The Cornell Aeronautical Laboratory, through the courtesy of Miss Elma T. Evans, added translations to those previously given.

Additional gifts were received from the Airborne Instruments Laboratory; American Management Association; British Information Services; British Messier, Ltd.; Douglas Aircraft Company, Inc.; General Electric Company; International Civil Aviation Organization; The International Nickel Company, Inc.; Nationaal Luchtvaartlaboratorium of Holland; Meteorological Department of Transcontinental and

Western Air, Inc.; Hugh Montagu; 1st Viscount Trenchard; U.S. Civil Aeronautics Board; U.S. Library of Congress; Alderman Library of the University of Virginia; and Westinghouse Education Foundation.

I.A.S. Newslines

▶ World War II is "the last war we'll ever win," according to **Gen. H. H. Arnold,** retired Chief of the Air Force and Honorary Fellow of the Institute. "We'll lose, and the enemy we fight will lose, because victory in atomic warfare is no longer possible," he added in an article in *This Week* magazine. General Arnold recommends that "we wage peace with all the air power, all the machines, and with all the money and men we used to fight Germany and Japan." Early last month, the general was elected President of the California Fish & Game Commission.

▶ Congressional Aviation Policy Board has named **W. A. M. Burden,** Honorary Member and former Assistant Secretary of Commerce for Air, to the Board's Subcommittee on Government Organization as Consultant.

▶ **William H. Klenke, Jr.,** General Sales Manager, Stinson Division of Consolidated Vultee Aircraft, was elected Vice-Chairman of the Personal Aircraft Council of A.I.A. An I.A.S. Associate Fellow, Klenke served as a Marine Corps pilot during the war.

▶ On an inspection tour of bases in the Mediterranean area, **Lt. Gen. Curtis E. Le May,** Commander of U.S A.F. in Europe and Honorary Member of the Institute, flew his own B-17 to North Africa, where he visited Mellaha Airfield, American-built A.T.C. base used during the war. Mellaha, near Tripoli in Libya, is being reopened "because of additional supply-carrying transport flights necessary to serve American missions in the Middle East, including the mission to Greece and the air base at Dharhran in Saudi Arabia," according to U.S. air officials in Europe.

▶ **Wynn Laurence Le Page,** formerly President of Platt-Le Page Aircraft Company, is Executive, Adrian Bauer Advertising Agency, Inc. He is an Associate Fellow of the Institute.

▶ I.A.T.A. meeting in London early last month called **John C. Leslie,** Vice-President, Pan American World Airways and Fellow of the Institute, from New York to the British capital. Leslie, recently made a member of the International Air Transport Association's Executive Committee, attended a meeting of the Administrative subcommittee, which meets quarterly to handle those administrative functions of I.A.T.A. which cannot be handled by the Association's officers.

William H. Klenke, Jr.

▶ On a special survey mission for Pan American, **Charles A. Lindbergh,** an I.A.S. Fellow, spent about a week in China last month studying the civil aviation picture there.

▶ Canadian Car & Foundry has named **Richard J. Moffett** as Technical Assistant to the General Manager. An I.A.S. Associate Fellow, Moffett had been Production Manager with de Havilland Aircraft (Canada) Ltd.

▶ A consultant in planning a new, large wind tunnel at Wright Field, **Dr. John R. Weske,** Consulting Aerodynamicist for Sverdrup & Parcel, and an Associate Fellow of the Institute, is also teaching a course at the U.S.-A.F. Institute of Technology.

Corporate Member News

• New Year prediction. . .Another good year for the aluminum industry was forecast by Roy A. Hunt, President of **Aluminum Company of America.** Production in 1947 was approximately 1,140,000 lbs., 39 per cent above previous year's output.

• **American Airlines System** reports passenger miles flown in 1947 set a high record at 1,500,000,000 against 1,308,000,000 in 1946. Number of passengers carried was 2,750,000 as against 2,485,589 in 1946.

• Navy Department is installing a combustion research unit for use in studying guided missiles at **Bell Aircraft Corporation** plant at Niagara Falls.

• More new aircraft models were introduced by **Boeing Airplane Company** in 1947 than in any previous year in Boeing's 31-year history. Total of four new models, including jet bomber and liaison plane, were flown for first time last year. . .Company's wholly owned subsidiary, Boeing Aircraft, was merged with the parent organization last day of 1947.

• **Chance Vought Aircraft Division** of United Aircraft has been negotiating with Navy and Dallas Chamber of Commerce for an agreement under which company will move its entire operation to former North American Aviation Plant B at Grand Prairie, Tex. Lease of the 1,368,700-sq.ft. plant from Navy would be for 1 year—agreement is expected soon.

• Employment at **Eastern Air Lines** on January 1 totaled 7,660, an increase of 16 per cent over the 6,600 on the rolls a year ago.

• New Washington office has been leased by **Fairchild Engine & Airplane Corporation,** which has taken over considerable space in the Standard Oil Building, 261 Constitution Ave., for a branch engineering office. New branch is to be staffed by some 200 engineers—draftsmen, electrical, mechanical, structural, layout, and weight. Most will be assigned to work on C-119 Air Force contract.

• Firestone aircraft wheels and brakes will be manufactured, distributed, and serviced by Hydra-Control Co., Pasadena, Calif., under licensing agreement with **Firestone Aircraft Company**. . .Hydra-Control will take over unfilled orders of Firestone.

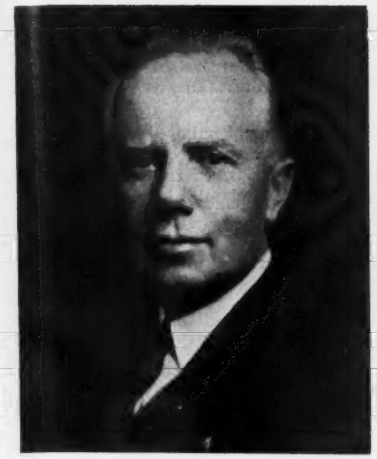
• New production schedule for latest G-E aircraft gas turbine has been set up by **General Electric Company.** Said to incorporate improved design and operation features and more thrust than any of previous G-E types, new gas-turbine details are still classified.

• Taximeter for planes. . .**Kollsman Instrument Division** of Square D Company has developed a power recorder to determine the cumulative power-hour units turned out by an engine. Power recorder is aimed for use by National Fly-Ur-Self System, Inc., but is expected to prove useful to commercial air lines as practical means for determining time for servicing engines.

• Supersonic car travels 1,019 m.p.h. . .**Northrop Aircraft, Inc.,** sent unmanned land vehicle hurtling over standard gage railroad tracks at a speed of 1,019 m.p.h. at Muroc Air Base, covering 2,000 ft. in less than 2 sec. Purpose of the experiment was to determine practicality of an "outdoor wind tunnel" on which Northrop could test advanced new airfoils at transonic and supersonic speeds.

• **Pan American World Airway System's** total passenger traffic in 1947 was estimated at 1,277,291,000 passenger-miles as against 791,227,600 in 1946. Number of passengers was 951,450 in 1947 and 854,570 the year previous. Company, which is adding 20 Boeing Stratocruisers and 20 Convair Liners to its fleet this year, expects continued growth in 1948 in both passenger and cargo operations.

(*Continued on page 12*)



I.A.S. Officers for 1948

President
John K. Northrop
President, Northrop Aircraft, Inc.

Vice-President
Smith J. De France
Director, Ames Aeronautical Laboratory, N.A.C.A.

Vice-President
C. L. Johnson
Chief Research Engineer, Lockheed Aircraft Corporation

Administrative Officers Re-Elected for 1948

S. Paul Johnston, Director

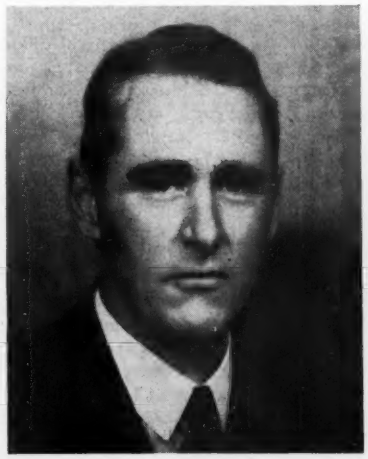
Bennett H. Horchler, Executive Vice-President

Robert R. Dexter, Secretary
Joseph J. Maitan, Controller

Vice-President
Raymond P. Lansing
Vice-President and Director, Bendix Aviation Corporation

Vice-President
Earl D. Osborn
President, Edo Aircraft Corporation

Treasurer
Sherman M. Fairchild
Head of Sherman Fairchild and Associates



Silicone News

DC SILICONES

You're Using Silicones Now

These materials were industrial infants five years ago. They have suddenly come of age. Even those of us who nursed them along are amazed at how far they have already gone. Today almost everybody benefits from Silicones in his every day living. For example, Dow Corning Silicones are now being used in every new car on the road, and in the automotive industry a new material must justify its cost to a fraction of a cent by increasing life or improving performance.

For Example: DC 200 Fluid damps vibrations of ammeters, gas gauges, speedometers, to give you more accurate readings—winter or summer.

For Example: DC 200 Fluid makes practical for the first time a viscous torsional vibration damper for automobiles and diesel engine crankshafts.

(DC Silicone Fluids have less tendency to thin out at high temperatures or to thicken at low temperatures than any other liquids usable for this purpose.)

For Example: DC Silicone Fluid, an ingredient of many heavy duty motor oils, stops foaming of the oil in the crankcase.

For Example: DC Silicone Fluid is used to prevent silking and flooding of some automotive finishes.

For Example: DC Mold Release Emulsion No. 35 simplifies production and improves quality of tires, mats, and other mechanical rubber parts.

These Silicone Fluids are only one of the forms in which DC Silicones are made. Many other automotive uses for DC Silicones are under development—Silastic* for gaskets, Silicone Greases for permanent lubrication, Silicone Resins for electrical insulation and for longer lasting protective coatings.

Silicones have been in commercial production at Dow Corning for nearly five years. They are basically different materials and often give unexpected advantages that can be discovered only by trying them. We have helped put them to work at a variety of jobs in industries of nearly every kind. Additional information and engineering assistance are available. Telephone the branch office nearest you or write for Catalog 51-9.

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In England: Albright and Wilson, Ltd., London

Dow Corning
FIRST IN SILICONES

(*Continued from page 10*)

• **Trans World Airline** decided not to curtail winter schedules this season because the high level of domestic and international operations reached last fall was expected to be maintained.

• Installation of its new communications center has been completed by **United Air Lines, Inc.,** at the company's Chicago headquarters. United operates a 15,000-mile network, which averages 2,500,000 messages per month. . .U. A. L. has transferred its reservations department from passenger service department to traffic and sales in preparation for change-over to new reservations system January 15. Known as "pay-load control," new system is a sell-and-record method.

• Midget mechanical pilot, weighing 35 lbs., has been developed by engineers of **Westinghouse Electric Corporation.** Unlike other automatic pilots, new unit is said to be unaffected by rapid maneuvers or high rates of acceleration.

Sections and Branches

Seattle Section

Vaughn Blumenthal, *Secretary*

Meeting at Bagley Hall, University of Washington, December 9, Section Chairman Jere Farrah presiding, a paper entitled "High Energy Ion Accelerators of Nuclear Physics" was presented to members in a nontechnical talk by Prof. Joseph E. Henderson, Director of Applied Physics Laboratory, University of Washington.

▶ **Possible Atomic Energy Use**—Dr. Henderson talked on the possible application of cyclotrons and atomic energy. In his paper he summarized the history of the development of nuclear physics and discussed the new cyclotron that is to be built and operated by the University of Washington.

The talk was concluded with a brief résumé of some of the things learned at the Bikini atomic bomb tests, which Dr. Henderson attended.

Hagerstown Section

J. Anthony Pauli, *Secretary*

Meeting November 25, 1947, in the Washington County Museum of Fine Arts, Roy W. Lessard, Chairman, presiding, members heard Harry Sawtell, Installation Engineer of General Electric Company, present a paper on "Aircraft Gas Turbines with Emphasis on Turbo-Props."

Introduced by Henry Billings, the speaker opened his address with definitions of jet and turbine engines, the jet engine, Sawtell said, being a pure jet propulsion gas turbine, while the turbine engine is a gas turbine for propeller drive.

▶ **Jet Propulsion Film**—A color film, *Jet Propulsion,* was shown which depicted the development of aircraft and engines from the Wright Brothers' airplane flown at Kitty Hawk in 1903 to latest jet aircraft.

Advantages of jet engines pointed out included elimination of vibration and several items necessary for operation of reciprocating engines.

Performance on any turbine is influenced by the "leaving loss" (velocity energy carried away by the exhaust stream), Sawtell said in discussing turboprop engines.

▶ **Curves Shown**—From a series of curves shown, jet engines appear superior at high speeds and short ranges, while propeller engines excel at lower speeds and longer ranges. Turbo engines seem to operate at greatest efficiency at highest allowable r.p.m. at which temperature is lowest.

Stresses in the rotating parts of a turbine engine are proportional to the square of the r.p.m., the turbine wheel being most the highly stressed, Sawtell said. The turbine buckets are the limiting hot parts of the engine, he added, and, if combustion temperature is kept constant, the bucket temperatures are decreased as the r.p.m. is increased.

▶ **Water Injection**—Possibility of increasing the maximum rating of the engine, Sawtell said, lies in the use of water injection. Theoretically, a water injection rate of 5 per cent of the airflow would increase the shaft output about 25 per cent at take-off conditions.

At the conclusion of his talk, Sawtell showed slides on rocket, ram-jet, turbojet and turboprop engines, in addition to a series of planes on which turboprops and jet engines were installed.

San Francisco Section

Don O. Horning, *Secretary*

At the December 4 meeting, Don Horning, Secretary, presiding, the Section heard Philip A. Colman, Chief Aerodynamic Engineer, Lockheed Aircraft Corporation, on "Analysis for Optimum Transport Airplane Configuration," a paper that he delivered at the I.A.S. Summer Meeting in Los Angeles, August 8, 1947.

In addition to Colman's paper (AERONAUTICAL ENGINEERING RE-

VIEW, Vol. 6, No. 12, p. 20, December, 1947), a film, *Antarctic Expedition*, was shown by permission of the Navy.

Wichita Section

Jerry H. Gerteis, *Secretary*

An interesting discussion on the topic of "Piloting Technique of High-Speed Aircraft" and a film, *Fighter Pilots in Action*, prepared by the Eighth Air Force Fighter Command, was shown to members gathered at Droll's English Grill, December 4.

Program Chairman, Prof. Kenneth Razak, was discussion leader of a group composed of Lt. Paul Houser and Majors E. R. Fry and K. S. Hodges, all of the 127th Fighter Squadron based at the Municipal Airport in Wichita.

▸ **Pilot's Complaints**—The discussion began with detailed description of cockpit checks that are required on modern fighter aircraft. Included were some of the pilot's complaints relative to cockpit arrangement and the designer's location of switches, landing-gear levers, etc.

All the pilots in the discussion group had had extensive experience during the war in the European theater of operations and were well informed on the requirements for fighter aircraft. Many interesting experiences were related by the men.

Tom Salter, Section Chairman, presided at the meeting.

Academy of Aeronautics

"Jet Propulsion" was the subject of a lecture given at the November 18 meeting by Robert A. Cole, Project Engineer of the Wright Aeronautical Corporation Wood-Ridge plant.

Demands for speed and more speed, Cole said, brought about development of an engine that would not be impeded by a propeller's limitations.

By means of slides, the early development of the jet engine was shown, and a typical engine was analyzed from air inlet to jet thrust nozzle.

Each of the constituent parts was fully described as to its purpose and importance. Cole then gave a detailed description of jet-engine performance including speed, fuel consumption, and efficiency. New jet planes produced by Boeing, Douglas, and other large aircraft companies were shown by slides to illustrate present-day advancement in jet propulsion.

At the December 2 meeting, Chairman Martin Glenn introduced Robert Ehrler, Jr., Director of Engineering Personnel at Chance Vought Aircraft Division of United Aircraft Corporation, who spoke on "Personnel Problems."

He stressed the fact that too many engineers and technical men have a large knowledge of facts and data but are unable to put it to good use. These people Ehrler termed "knowers." Main purpose of the Chance Vought Personnel Department is to convert the "knowers" into "doers."

Ehrler further brought out the importance of the individual in any industry and how problems are overcome more easily when there is a closer understanding between employer and worker.

In conclusion, Ehrler gave three main criteria used by his company in assessing a person for a job—mental capacity, emotional stability, and self-understanding.

A joint meeting of I.A.S., Society of Aviation Technicians, and Air Force Association student organizations was held December 9. Guest speaker was C. E. Anthony, Manager of Aviation Division, General Electric Company.

Anthony opened with a film, *Jet Propulsion*, showing early development and present-day use. The complete operation of a jet engine was illustrated and explained by means of cartoons and other illustrations.

Chairman Martin Glenn presided at the meetings.

Alabama Polytechnic Institute

The November 11 meeting, presided over by Chairman Wilmer H. Reed III, was confined to business in which final details were worked out for a group picture to represent the local organization in the college annual.

In addition, a committee of four was appointed to make complete plans for a weiner roast and party held November 22.

Calendar

I.A.S. Section Meetings

DETROIT—MARCH 9

Engineering Society of Detroit

Speaker: Robert Stanley

"XS-1 Supersonic Airplane"

PHILADELPHIA—MARCH 30

Engineers Club

Speaker: Col. Leslie E. Simon

"Aerodynamics Work of the Ballistic Research Laboratories in the Transonic and Supersonic Field"

Cal-Aero Technical Institute

The December 2 meeting opened with a business session. Chairman Jose Diaz presided.

Following the business meeting, W. A. (Dick) Pulver, Lockheed Aircraft Corporation Project Engineer, introduced by faculty member Jim Wilson, gave a talk on the Constitution aircraft.

Construction and maintenance features of the plane were discussed and illustrated by slides, both color and black and white. Among the highlights of the aircraft's equipment were the hydraulic booster system designed to give the pilot "feel" and ease of control; elevator and rudder control cables traveling in a straight line the full length of the fuselage in order to reduce friction; complete power package unit of the engines; and a special light to indicate to the pilot when the wheels touched down, which, because of prerotation of landing wheels, could not be detected otherwise.

Carnegie Institute of Technology

On December 11, Branch members visited the National Advisory Committee for Aeronautics Flight Propulsion Research Laboratories in Cleveland where the N.A.C.A. carries out its basic and applied research work on engines for supersonic aircraft. Basic principles and advantages of the turbojet and ram-jet engines were explained.

At the turbine test chamber, principles of the engine test cells and method of obtaining basic data from the axial-flow compressor chamber were explained. Other projects visited by the group included the centrifugal compression chamber, control room, refrigeration building, wind tunnel and supersonic tunnel, Icing Research tunnel, and the N.A.C.A. hangar where various aircraft used in experimental work were inspected.

University of Colorado

The second meeting of the Branch, held November 13, featured a film, *Jet Propulsion*, and a talk by Prof. K. D. Wood, Dean of the Aeronautical Engineering Department.

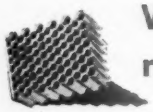
Following the showing of the film on jet engine principles, Professor Wood elaborated on a few of the fundamentals of jet propulsion for the 138 students present.

Chairman Randall C. Maydew presided.

Illinois Institute of Technology

A business meeting of the Branch held December 4 and presided over by

STRENGTH travels with LIGHTNESS
in the Boeing 377 Stratocruiser



Weldwood Honeycomb walls add rugged stiffness . . . subtract weight

THOSE new Boeings . . . they're big. Able to carry 81 passengers cross country, or 114 on commuter flights. With loads like that, they can't tolerate any deadhead weight.

Every square inch of material must justify itself in three ways: in lightness, in rugged strength, and in dimensional stability.

Weldwood* and Armorply* Honeycomb boast an amazingly high strength-weight ratio. The multicellular core weighs as little as 4 lbs. per cu. ft. The facing can be beautifully grained matched veneer, gleaming aluminum, stainless steel or plastic. Honeycomb's mechanical properties, rigid strength, and insulating qualities offer the plane designer many advantages.

Honeycomb core can be made of impregnated cloth, paper, Fiberglas, or other material. Armorply and Weldwood Honeycomb are available in stock sheets, contoured panels or semi-finished form to your specifications. Get full engineering data on these spectacular airworthy materials. Write today.

*T.M. U.S.P. Co.

Installing Armorply Honeycomb wall of ladies' dressing room in the Boeing 377 Stratocruiser.

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Chairman Kenneth F. Gerleman discussed possibilities of an I.A.S. demonstration and display during an Open House at the Illinois Institute of Technology scheduled for next May.

A committee was appointed to carry out suggestions made during the meeting. The Branch would appreciate any suggestions of successful exhibits conducted by other Branches.

University of Illinois

A showing of films of the National Air Races taken at Cleveland last year drew a record attendance of 210 to the December 17 meeting. Robert S. Chubb, Chairman, presided.

The films were in color and covered nearly all the events that took place at the races. Included were a parachute drop from a C-82; JATO of the Truculent Turtle, distance record breaking Navy plane; and midget plane races. Aerobatics of a captured German trainer were also shown.

Polytechnic Institute of Brooklyn Branch Field Trip—*Approximately 33 Student Members of the Polytechnic Institute of Brooklyn Branch visited the Grumman Aircraft Engineering Corporation's plant at Bethpage, L.I., November 21. Part of the group is shown at Grumman.*

Polytechnic Institute of Brooklyn

Announcement of a field trip to the Grumman Aircraft Engineering Corporation plant at Bethpage, Long Island, set for November 21, was made by Chairman Hrant Yousoufian, who then turned the floor over to Sebastian B. Nardo, Associate in Aeronautical Engineering at P.I.B.

Nardo gave a report on "Low Drag Airfoils," explaining in some detail the development of the airfoil from a flat plate to a scientifically designed section.

By use of diagrams and sketches, Nardo illustrated the forces acting on the airfoil as a result of its motion relative to the ambient air and graphed their relations to one another. He also pointed out the main characteristics of the "four-" and "five-digit" series.

In explaining the need for the low-drag airfoil developed during the war years, Nardo brought out that the drag due to the skin friction of the conventional airfoil constituted roughly 85 per cent of the total drag of the airfoil. Skin friction, he continued, is dependent upon the airfoil boundary layer of air, which may be either turbulent or laminar, the turbulent condition producing high skin-friction drag and the laminar flow condition producing low skin-friction drag.

The six-digit series, he explained, was designed to control the boundary layer over the airfoil surface to reduce drag and thus permit higher velocities. He concluded by comparing the general outline and properties of the low-drag airfoil section with those of the conventional airfoil section.

The film, *Report on Jet Propulsion*, concluded the meeting.

The December 9 meeting was opened by Chairman Yousoufian, who gave a favorable report on the organization's first postwar field trip—to the Grumman plant at Bethpage—and announced the title of the film to be shown at the meeting, *PBM-3 Wing Destruction Test*, made by The Glenn L. Martin Company.

Rensselaer Polytechnic Institute

Chairman Robert Bower opened the December 4 meeting at which A. J. Fairbanks, Professor of Aeronautical Engineering, Rensselaer Polytechnic Institute, gave a talk on the development and theoretical considerations in glider design.

The talk included a brief history of glider development since the nineteenth century. Many practical problems were discussed in connection with glider construction, flying, and pilot instruction. A summary of record-breaking flight methods concluded Professor Fairbanks' lecture.

A sound film, *Gliding Wings*, was shown. Produced by the Ford Motor Company, it showed construction of Army paratroop and war implement-carrying gliders.

Syracuse University

The third meeting of the Branch opened December 3 with a showing of Bell Aircraft's film on *Jet Propulsion*.

A business meeting then was held under Chairman Elton Bischoff at which plans for an annual banquet were discussed, together with the possibility of obtaining an Air Force Reserve plane for inspection at a local airport.

University of Texas

"Aerophotography" was the subject of a talk given at the November 3 meeting by E. D. Coltharp, aerophotographer and member of A.S.C.E.

Coltharp spoke to the group on the types of aircraft used by the Air Force, Navy, and civilians for aerophotography and on the features required in the use of these planes.

Two films were shown at the November 17 meeting: *Aerodynamics and Airfoil Structures* and *S.M. U. vs. Texas U. Football Game.*

Chairman Alexander A. Cunningham presided at the meetings.

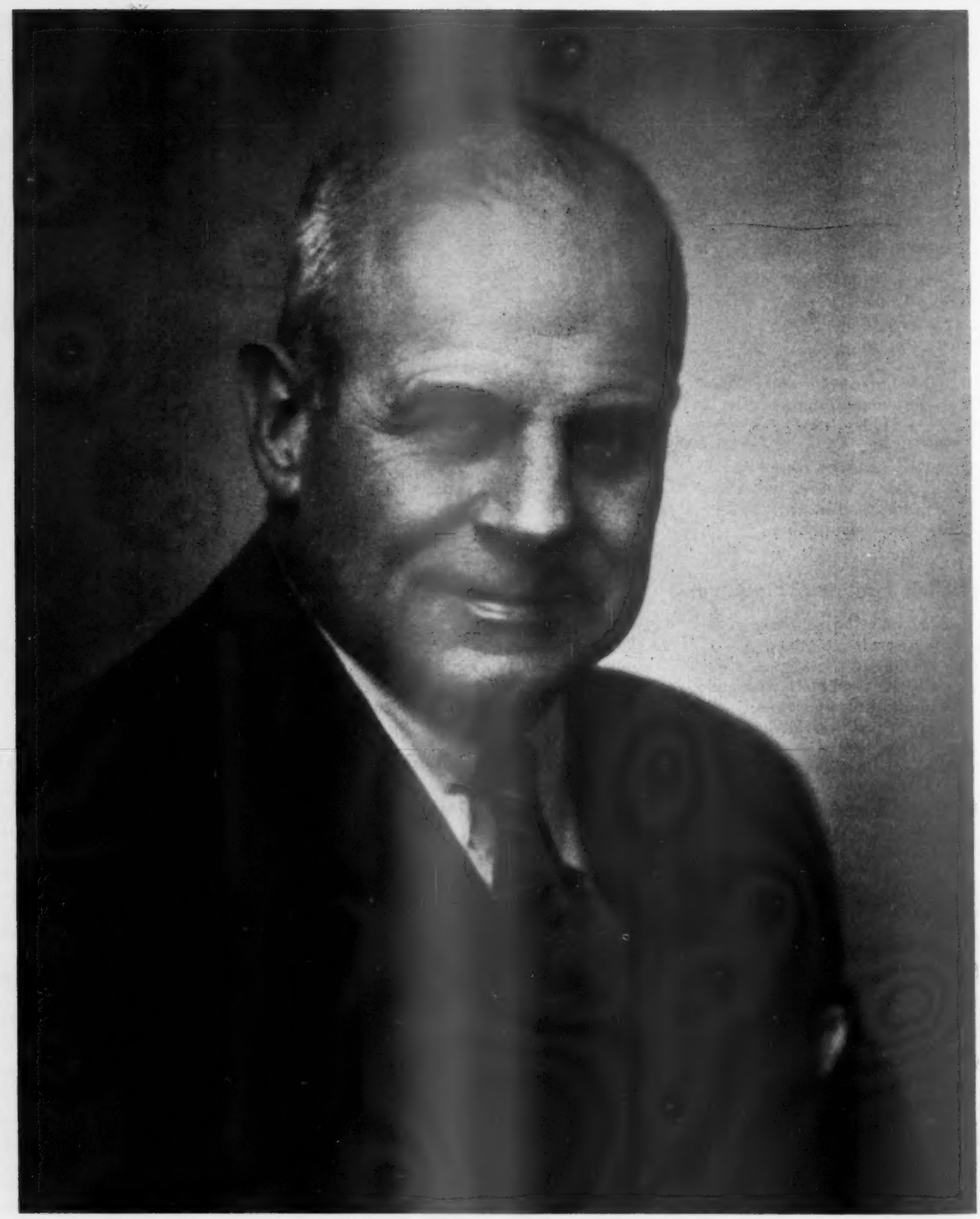
Tri-State College

Following the showing of the film, *The Lockheed P-80*, a business session was held at the December 3 meeting. Plans for a banquet to be held with the last meeting of the term were made and candidates for office for the next term were nominated.

Clifton A. Smith, Chairman, presided. Faculty members of the Aeronautical Department—S. M. Acton, Honorary Chairman, and H. R. Wright—were present.

At the banquet-meeting December 10, officers for the winter term of 1948 were elected as follows: Chairman, D. H. Kintis; Vice-Chairman, D. W. Ellison; Secretary-Treasurer, W. C.

(*Continued on page 73*)



Honorary Fellow for 1947

James H. Doolittle, Vice-President and Director, Shell Union Oil Corporation

Editorial

—To Whom Honor Is Due

It was with particular satisfaction that we received the report of the election of the Honorary American Fellow for 1947 by the Fellows of the Institute. It seemed especially fitting that the man whose scientific approach to the problems of modern air warfare should be honored by the Institute's highest award. We, in turn, are honored by his acceptance. We welcome into the distinguished company of Honorary Fellows, James H. Doolittle.

It is wholly unnecessary to attempt to outline General Doolittle's career for an Institute audience. It would be wholly impractical to try to do so within the limits of the REVIEW'S editorial page. Suffice it to say, however, that he possesses to an unusual degree the attributes of the scientist and the practical engineer. He is capable of dealing mathematically and in the abstract with the best of them. He is, at the same time, ready, willing, and able to put the ideas in which he believes into practice anywhere, anytime, and under any circumstances—a characteristic that will be long remembered by certain people in Germany and Japan.

Jim Doolittle's services to his country go far beyond his military exploits. For over 30 years his every effort has been directed toward the advancement of aviation in America. There has been scarcely any new device by which man could fly faster or farther or more safely but that Jim was among the first to try it. As a pilot, there are few better. But he has always been more than that. He is an Airman in the broadest sense. He is one of the great leaders of the Air Age. As such, it is eminently fitting that he has been elected to the company of the Honorary Fellows.

One of aviation's greatest awards is The Daniel Guggenheim Medal, given each year for "notable achievement which shall tend to the advancement of aeronautics." Established in 1928, it is held in the joint custody of the American Society of Mechanical Engineers, the Society of Automotive Engineers, and the Institute of the Aeronautical Sciences. A joint board makes the selection yearly. As announced in the REVIEW for July last, the 1947 award went to Lester Durand Gardner "for his outstanding achievement in advancing aeronautics, particularly for his conception and organization of the Institute of the Aeronautical Sciences." It was the Institute's privilege to include the presentation of the medal at its Honors Night Dinner this year.

Other well-known names appear on the Institute's 1947 honor list. The ten American Fellows, elected by secret ballot from among the Associate Fellows, are listed on page 8. To them, our heartiest congratulations, and a warm welcome to the Fellowship of the Aeronautical Sciences.

Five special awards are given at Honors Night this year. Of the usual six, it will be remembered that the Bane Award, for outstanding work by an Air Force officer or civilian, was presented at the 1947 Annual Summer Meeting at Los Angeles in August. Without going into details, which will be found on pages 6 and 7 in this issue, the other five are (in alphabetical order): the Chanute Award for flight-test research; the Jeffries Award for advancement in aeromedicine; the Losey Award for work in meteorology; the Reed Award for outstanding experimental or theoretical work; and the Sperry Award to a young man for the advancement of aeronautics. The selection of the recipients for all these awards is by secret ballot of the Trustees of the awards, or by the Council of the Institute, depending upon the wishes of the donors.

By giving due recognition to those who contribute to the year-by-year progress in aviation, the Institute, through its Honors Night program carries out one of its most important functions, the fostering and encouragement of the arts and sciences of aeronautics. And it gives us all, members and Fellows of the Institute, an annual opportunity to render honor to whom honor is justly due.

S. P. J.

Engineering for Safety

WILLIAM I. STIEGLITZ*

Republic Aviation Corporation

SUMMARY

Because of the rapid increase in the amount of flying, the total number of aircraft accidents has increased despite a reduction in accident rates. An acceleration in the rate of increase in safety is therefore imperative. The need for special safety groups to accomplish this is stressed.

The evolution of Republic's safety program is described, and it is shown how the present organization is set up to eliminate the factors that loom large in present-day accident statistics. The composition, functions, and procedures of the Engineering Safety Board and Engineering Safety Committee, and the duties of the safety specialist, are described. It is shown how Republic's safety organization combines the specialized knowledge of a safety expert with that of various other technical specialists to form a working group whose primary function is the elimination of potential causes of accidents during design stages.

The need for obtaining the participation of all employees in the safety program is stressed, and means are described by which this may be accomplished.

INTRODUCTION

THE MOST SERIOUS PROBLEM that the aviation industry faces today is that of safety. Newspaper accounts of aircraft accidents, whether they be in air-line, military or private flying, are usually lumped under one headline listing the total number of crashes and casualties, and all react against public confidence in flying. This was demonstrated by the reaction of the public, the press, and of Congress to the air-line accidents last winter and spring.

This loss in confidence is unquestionably a factor in the aviation industry's present economic problem. The effect cannot be measured quantitatively, because it is impossible to determine the number of potential purchasers of personal aircraft or the number of potential air-line passengers who remain part of the nonflying public because of fear.

A review of accident statistics reveals a steady downward trend in accident rates. In the past few years, however, the amount of flying has increased more rapidly than accident rates have decreased, with the result that more accidents, and more fatalities, are reported in the daily press. These figures, not statistical trends, impress the layman.

No one can challenge the statement that further improvement in aviation safety is a must. In fact, the rate of improvement will have to be greatly accelerated if a rapid increase in the total number of accidents and fatalities is to be prevented.

EVALUATION OF THE RECORD

The record of past improvement may, from an engineering standpoint, be extremely encouraging, but it is important primarily as a means of determining how safety has been increased, and how further improvement may be achieved. A study of the record leads to the conclusion that a large part of the improvement has been the result of increased knowledge of the art. We made safer airplanes because we made better airplanes.

The most common causes of accidents a comparatively few years ago were poor aerodynamic characteristics, structural failure, and engine failure. These were obvious shortcomings in aircraft from an engineering standpoint, and, as engineers, we set to work to overcome them. The success of this effort is shown by the record.[1, 2] Accidents caused by inherently dangerous flying characteristics or structural failure are virtually unheard of on modern aircraft, and engine failure is no longer a major factor in accident statistics.

So small a percentage of present-day accidents results from these three causes that, although further improvement along these lines can and must be made in order to achieve better flying, more comfortable and more efficient airplanes, this cannot appreciably affect the safety record. The primary effect of most improvements now under development will be to increase utility while maintaining the present level of safety.

SAFETY PER SE

From such considerations, it may be concluded that the past rate of increase in safety cannot be maintained, let alone accelerated, unless there is a definite and concerted effort to achieve safety per se. Accidents must be analyzed so as to prevent others from the same cause, and, more important, the potential causes of accidents must be found and eliminated. Both Wood[3] and McFarland[4] have previously expressed this same conclusion in advocating "postaccident" and "advance accident" analysis.

In addition, we must recognize the fact that some accidents will be unavoidable, and we must design to minimize the number and severity of the resulting injuries. Our objective must be not only a lower accident rate but also a higher survival rate.

THE NEED FOR SAFETY GROUPS

In short, safety must be designed and built into airplanes, just as are performance, stability, and structural integrity. A safety group must be just as important a part of a manufacturer's organization as a stress, aerodynamics, or weights group, and must have as much influence on all design decisions. Wood[3] fully described the value of such a group almost 2 years ago, and there is little that can be added to his general statement.

* Design Engineer—Safety.

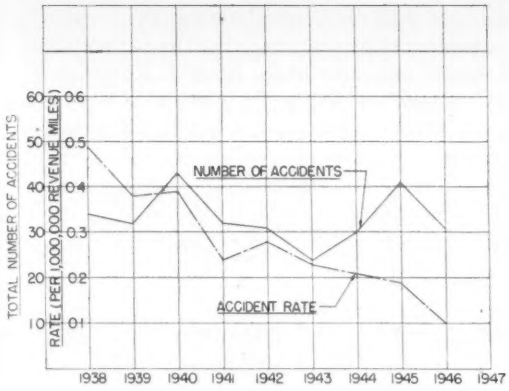

TOTAL NUMBER OF ACCIDENTS
RATE (PER 1,000,000 REVENUE MILES)
NUMBER OF ACCIDENTS
ACCIDENT RATE
1938 1939 1940 1941 1942 1943 1944 1945 1946 1947

FIG. 1. Trends in number of accidents and accident rate—scheduled domestic air-line operation (from C.A.B. statistics).

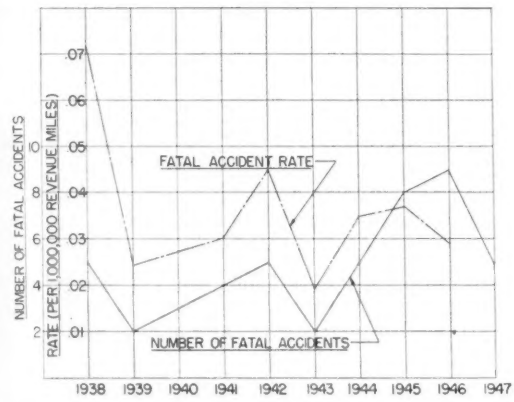

NUMBER OF FATAL ACCIDENTS
RATE (PER 1,000,000 REVENUE MILES)
FATAL ACCIDENT RATE
NUMBER OF FATAL ACCIDENTS
1938 1939 1940 1941 1942 1943 1944 1945 1946 1947

FIG. 2. Trends in number of fatal accidents and fatal accident rate—scheduled domestic air-line operation (from C.A.B. statistics).

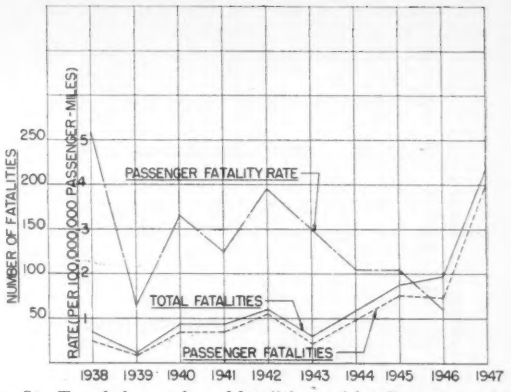

NUMBER OF FATALITIES
RATE (PER 100,000,000 PASSENGER-MILES)
PASSENGER FATALITY RATE
TOTAL FATALITIES
PASSENGER FATALITIES
1938 1939 1940 1941 1942 1943 1944 1945 1946 1947

FIG. 3. Trends in number of fatalities and fatality rate—scheduled domestic air-line operation (from C.A.A. statistics).

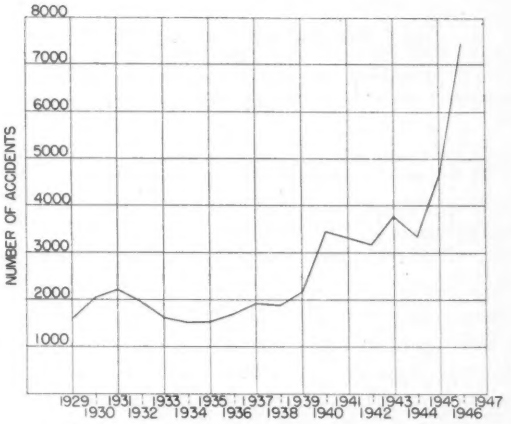


FIG. 4. Trend in number of nonair carrier accidents (from C.A.A. and C.A.B. statistics).

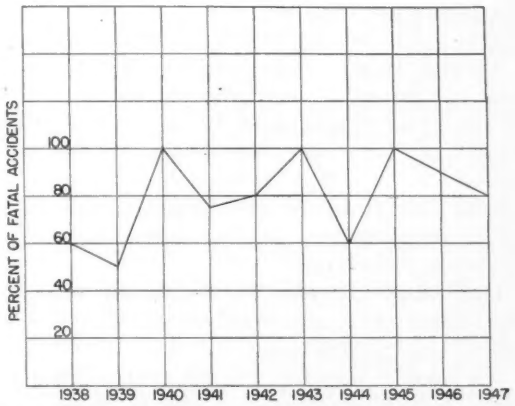


FIG. 5. Percentage of fatal accidents in scheduled domestic air-line operation caused by personnel error, weather, and failure of functional systems (for 10-year period factor is 75 per cent) (from C.A.B. statistics).

Some companies have already established accident prevention groups or have appointed safety specialists. There is an urgent need for such action by *all* manufacturers, whether they build personal, transport, or military aircraft, if aviation is to become increasingly safer.

A safety program can be organized in numerous ways and there is probably no one best way. The most suitable procedure for any company must depend on the nature of its activities, and its general organizational setup. Safety organizations now in existence vary widely in form. The important thing is that such an organization be established, regardless of its form.

Evolution of a Safety Organization

The safety group at Republic differs from others with which the author is familiar primarily in that it is an integral part of the Engineering Department.

The development of our present organization has been an evolutionary process, extending over several years. In the necessarily rapid expansion during the war, there was no definite safety organization as such. Accidents were investigated by the Service Department and the Service Engineering group, and reports were circulated to all departments. A close check was kept on these reports, and any trend or pattern was cause for follow-up action. An example of the safety work being done at that time is the development of the first 40*g* cockpit in the country for the P-47D series. This eliminated pilot fatalities resulting from failures of seats, belts, harnesses, and their attachments, in crashes in which the cockpit structure had remained intact.

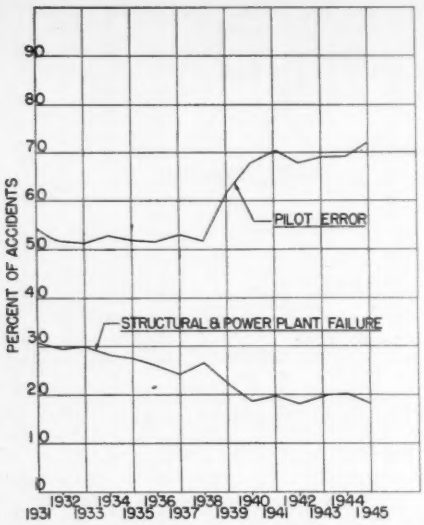


FIG. 6. Percentage of nonair carrier accidents caused by pilot error and structural and power-plant failures (from C.A.B. statistics).

The war gave a definite impetus to work on problems of flying safety, and a great many reports on this subject were released by Government agencies, such as the Army Air Forces' Aero-Medical Laboratory and Flying Safety Service, the Navy Bureau of Medicine, and the National Research Council Committee on Aviation Medicine, and by numerous private agencies.

It was apparent that this material contained a wealth of information on accident causes and means of prevention. For these data to be of maximum utility in design work, it was necessary that they be subjected to careful engineering analysis, and summarized for wide distribution and ready reference.

This led to our appointing an engineering safety specialist to collect and disseminate information and to serve as a consultant and adviser on safety. To provide the broadest possible base for safety studies, additional data were obtained from air lines, insurance companies, C.A.A., C.A.B., and Crash Injury Research. All material was analyzed and studied for application to design, and abstracts of pertinent information were distributed to all concerned.

These studies indicated that the majority of present-day accidents result from weather, personnel error, and failure of functional systems.

The aircraft manufacturer's role in eliminating accidents resulting from weather is largely limited to the development of high-altitude aircraft, and of airplanes incorporating those handling qualities essential to instrument flight. Aside from this, solution of the weather problem lies primarily in other hands.

It was found, however, that most accidents traceable to failure of functional systems result from poor detail design, and that the biggest single cause of accidents—personnel error—can frequently be traced to detail design that encourages such errors.[4]

With this established, it was evident that a safety program of broader scope was needed, and that, in addition to the work already undertaken, the program must be organized to insure a constant close check on all detail design, especially of the functional systems.

As changes are frequently impossible after a basic design has been established, it followed that this check must start in the preliminary design stage in order to be fully effective. It was therefore considered essential that the organization be an integral part of the Engineering Department, and that it have the authority to enforce its decisions.

Present Safety Organization—Its Composition, Functions, and Procedures

These conclusions led to the establishment of Republic's present safety organization, headed by the policy-making Engineering Safety Board, with an Engineering Safety Committee, responsible to the Board, as a working group.

The Safety Board

The Safety Board is composed of the Chief Design Engineer, the Chief Project Engineer, the Chief Staff Engineer, the Power Plant Staff Engineer, and the Chairman of the Engineering Safety Committee. The function of the Board is to establish general safety policies, which are transmitted to the Safety Committee for execution, and to decide controversial problems of safety, which are referred to the Board as will be outlined later.

It should be noted that the Board membership includes the immediate supervisors of all engineering department heads, project engineers, and staff engineers, so that there can be no question as to the authority of Board decisions.

There is no permanent chairman of the Board, the post being held by all members in rotation. In this way, all Board members are given equal responsibility and play an equally active part in carrying out Board functions. Regular meetings are held every 2 weeks,

Inter-Office Correspondence
REPUBLIC AVIATION CORPORATION
Farmingdale, New York

To: Chief Engineer, Chief Design Engineer, Chief Project Engineer, Chief Staff Engineer, All Staff Engineers, All Project Engineers

From: Chairman—Engineering Safety Committee

Subject: *Personnel Error in Aircraft Accidents*

PILOT ERROR OR DESIGN ERROR?

Who Made the First Mistake?

FIG. 7. Heading of typical safety memorandum. This memorandum cited specific accidents, summarized accident statistics, and discussed means of minimizing personnel error through design.

with special meetings called by the Chairman of the Safety Committee whenever controversial questions require immediate action.

The Safety Committee

The Safety Committee is composed of a group of staff engineers, with the engineering safety specialist as chairman. Each staff engineer is responsible for all detail design in his specialty, and all drawings must be approved by the staff before release. This provides an independent check of all design by a technical specialist not a part of the project group and affords a correlation between projects in eliminating safety hazards.

In case of disagreement on questions of safety between a staff engineer and the project engineer involved, the latter is invited to attend the next meeting of the Safety Committee to discuss the problem. If agreement cannot be reached, the Chairman of the Safety Committee then refers the question to the Safety Board for decision.

In addition, action on many questions of safety is initiated by the Committee and referred to the project through the proper staff engineer. Questions that do not fall within the province of any particular staff engineer are followed up directly by the Chairman of the Committee.

Copies of all test pilot crabs, Inspection reports, Field Service reports, etc., go to the Chairman of the Safety Committee for review and necessary follow-up action. Items involving safety are brought before the Safety Committee, and a decision is made by the group as to whether a design change is desirable. The appropriate Committee member is then instructed to follow up with the project and report back to the Committee. No item is dropped from the agenda until satisfactory action has been taken.

REPUBLIC AVIATION CORPORATION

File: .....
cf: .....

ACCIDENT REPORT SUMMARY

Date: .....

Aircraft Make and Model: .....
Name of Operator: .....
Date and Time of Accident: .....Location: .....
Weather: .....
Extent of Damage: Washout..; Major..; Minor..; None..
No. of Occupants: Crew: .....Passengers: .....
No. of Casualties: Crew: Fatal..; Severe..; Minor..
Passengers: Fatal..; Severe..; Minor..
Nature of Accident: .....
.....
Probable Primary Cause: .....
.....
COMMENTS:

FIG. 8. Accident Report Summary Form used for files.

(NAME)

ENG'R. SAFETY BOARD

IS AUTHORIZED TO EXAMINE DAMAGED AIRCRAFT AFTER ALL IMMEDIATE DANGER IS ENDED.

(SIGNED)
PRESIDENT

FIG. 9. Special badge furnished Safety Board members to authorize passage through police lines at scene of accident. Safety Committee members have similar badges.

Classification of Design Changes

All recommended changes to production aircraft are assigned a priority by the Safety Committee, based on the degree of hazard involved. Changes are classified as: "A"—immediate and retroactive; "B"—at earliest possible date, regardless of scrapping of parts or material; or "C"—at earliest convenient date, with due regard to schedules and parts on hand. A staff engineer is authorized to assign a "C" classification, but "A" or "B" classifications must be authorized by the Committee as a group. In actual practice, staff engineers seldom assign "C" classifications without first obtaining Committee opinion as to the advisability of a higher priority.

The Safety Committee also acts as a mock-up board and as a preflight inspection board on prototype aircraft, and a complete report of the findings and recommended changes is issued. As in the case of production aircraft, priorities are assigned to recommended changes on a prototype but in this case are classified as: "A"—before first flight; "B"—before delivery; or "C"—for future aircraft.

The Safety Specialist

The Chairman of the Safety Committee still continues his previous duties as safety specialist, reviewing all available safety reports and issuing memoranda summarizing these reports to all personnel concerned. In addition, he is responsible for statistical analysis and engineering investigation of accidents to company airplanes.

Accident Investigation and Analysis

Routine investigation of accidents occurring away from the factory is still conducted by the Field Service Department, which works in close cooperation with the engineering safety specialist. The latter is responsible for technical analysis of such accidents. In the case of accidents involving engineering, it is the responsibility of the engineering safety specialist to issue a complete report, including the history of the accident and subse-

quent investigation, discussion of the findings, conclusions as to the cause of the accident, and recommendations for prevention of recurrence. All such accident reports and analyses are reviewed by the Safety Committee as a group prior to issuance.

One of the most difficult problems in accident analysis is to establish a sound definition of an accident. Wills[5] has stated: "The first law of accident investigation (is) that the amount of damage done in an accident has no bearing on the importance of the accident from the 'prevention of further accidents' point of view.

"Frequently, a valuable lesson can be drawn from an 'accident' in which no damage is done; and conversely, no lesson at all from a fatal accident involving the loss of an aircraft and many lives."

It is sometimes extremely difficult to get adequate data on "near-accidents," particularly on personal aircraft on which owners do not report minor difficulties to the manufacturer. However, we make every possible effort to obtain such reports and analyze them thoroughly to determine cause, so that corrective action may be taken before a more serious accident results.

The analysis of accident reports is not limited to company airplanes. Whenever possible, C.A.B. accident hearings are attended, and copies of accident reports are obtained. The entire history of each accident is carefully analyzed, not only for cause, but for factors contributing to the severity of the accident or the extent of personnel injury involved, and for any design lessons that may be learned. Reports on such accidents and the conclusions drawn therefrom are widely distributed.

Philosophy of Accident Prevention

The composition of the Safety Committee merits further consideration, since it expresses our entire philosophy of accident prevention. First, safety is a specialized subject just as are aerodynamics and structures. Every engineer cannot be expected to be thoroughly familiar with all developments in the field of safety any more then he can be expected to be an expert aerodynamicist. On the other hand, the safety specialist cannot be expected to be an expert in all phases of design on a complex modern airplane, and safety hazards can creep into almost any detail.

We have, therefore, combined the specialized knowledge of the safety expert with that of the staff engineers in a Safety Committee to form a working group competent to check and pass on *all* design.

Weekly meetings provide an opportunity for discussion of problems. At these meetings it is the function of the safety specialist, serving as Chairman, to keep the others informed of new safety information.

We fully realized that even such a group could not by itself achieve safety. No safety program can be fully effective without the active participation of every employee. We believed that in order to achieve this participation there were four essentials: first, that everyone be made to realize that no detail is too small to be important from the safety standpoint; second, that every man involved in design work be trained to scrutinize design not only from the standpoint of how well it will work, but also how it could malfunction, or how an error could be made in its use; third, that everyone be made to feel a personal responsibility for safety; and fourth, that a means be provided whereby anyone raising a question of safety can call it to the attention of the safety group.

The Man on the Board and the Man in the Shop

Therefore, at the time our safety organization was established, a chart was issued showing the definite line of appeal on questions of safety. It was clearly established that it was not only the privilege, but it was the duty of anyone questioning the safety of a design feature to make full use of the safety organization. Thus, if a draftsman questions the safety of a particular design feature and is overridden by his unit leader, he is expected to refer the matter to the project engineer, thence, if necessary, to the staff engineer concerned, and finally, to the Safety Committee.

A similar procedure has been followed in the shop, so that potential hazards in aircraft found by shop personnel are reported to foremen for transmittal, in writing, to the project engineer and the Chairman of the Safety Committee.

Safety Posters

The Safety Board has also initiated an extensive educational campaign through the use of safety posters. One series illustrates actual accidents that have resulted primarily from poor detail design. For these posters we have drawn on available accident reports from all sources, regardless of whose airplane was involved, although the actual aircraft is not identified. The posters have usually consisted of a small sketch of the detail causing the accident, combined with a drawing based on an actual photograph of the wreck. Captions have been of the type "Little Details Cause Big Accidents," "Don't Let This Happen to Our Airplanes," and "Failure of This . . . Caused This. Think Safety!"

We have also drawn on material for posters from other sources. For example, immediately after publication of the July issue of Aeronautical Engineering Review, we requested and obtained tear sheets of the editorial and "Pin-Up Picture of the Month," which were posted on bulletin boards throughout the Engineering Department.

Conclusion

The steady increase in the number of questions being referred to the safety group from all departments, including Engineering, Inspection, Factory, and Service, has been a gratifying indication of the growing consciousness of safety problems throughout our company.

The evaluation of safety work in positive terms is extremely difficult. When an accident does not occur,

INSTITUTE OF THE AERONAUTICAL SCIENCES

Editorial

Eternal Vigilance the Price—

Take a good look at the picture on the opposite page. Better yet, cut it out, pin it up on the wall or put it under the glass on your desk It is a picture of a plane-load of people. We don't know who they are. We don't even know whose airplane they are sitting in It doesn't matter What does matter very much, however, is that they are PEOPLE. They represent our ultimate customer, the traveling public. Somewhere along the line, from the inception of the design of the airplane until they are landed at their final destination, be we blueprint boy, project engineer, pilot, or top executive, their safety rests in our hands.

We are not talking here about *collective* responsibility. It is much closer to home than that. Every single person who has handled a tracing, pushed a slide rule, driven a rivet, inflated a tire, inspected a bolt, or sat in the pilot's seat carries a *personal* responsibility At some stage in the proceedings he, and he alone, has shouldered the full responsibility. That is the thing that no one of us must ever forget.

In the spring of 1947, the future of air travel has never been brighter but, paradoxically, seldom has the present outlook seemed blacker Legitimate pride in achievement has been dimmed by shocking disaster. Possibly we have all been a little overconfident. Possibly, because some of the things that used to be exciting and worth while in themselves have become routine, we have all tended to become a little careless That is the worst thing that could possibly happen C R. Smith once said something to the effect that the air as a medium of travel was not inherently dangerous but, like the sea, it extracts a terrible toll for carelessness. That is another thing we must never forget.

About 10 years ago I wrote an editorial for *Aviation* which was addressed to air-line maintenance men, based on the old story of the Horseshoe Nail. (Because the nail was lost, the horse went lame, the General missed an important engagement, the battle was lost, etc., etc.) All of which may be classed under the head of "pure corn," these days, but there is still a lesson in it, especially for the aeronautical engineering profession. Overlooking small details that may lead to disaster is the kind of risk that none of us can afford to take. The stakes are too high

Engineers as a group are sometimes inclined to forget that they are working for the benefit of PEOPLE. We become so absorbed in the problems of the machine *per se* that we often tend to lose sight of the ultimate purpose to which it is to be put. We sweat and strain over our performance curves, stress calculations, weight schedules, and weight estimates, making what concessions we must for the comfort and convenience of the human occupant, damning him meanwhile as one of those necessary evils without which we could make a better airplane!

So, take another look at our Pin-Up of the Month, the airplane passenger Pilotless aircraft, guided missiles, or no, we are going to have our human customer with us for a long time. The health of our industry, and the continuation of our own jobs, depend eventually on how well we take care of him. He wants to believe in us. He wants to use our machines and our services for his business and his pleasure, but the events of the past few months have strained his faith in our abilities. We can't afford to let him down. Every member of the Institute has a personal responsibility in the matter. Think it over, and keep an eye out for loose horseshoe nails!

S.P.J.

FIG. 10. Editorial and "Pin-Up Picture of the Month" from July, 1947, AERONAUTICAL ENGINEERING REVIEW used as safety poster.

it is impossible to prove that some particular design feature prevented it. The only means of evaluating results of this effort lies in overall accident rates.

We also realize that it is impossible to measure quantitatively the economic effects of increased safety, but we are thoroughly convinced that our efforts in this direction are resulting in safer aircraft, and are paying dividends in human life.

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[4] McFarland, Ross A., *Human Factors in Air Transport Design*, Chapt. 12, pp. 561–630, McGraw-Hill Book Company, Inc., 1946.

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Coming in the March Review

"Sixteenth Annual Meeting of the Institute of the Aeronautical Sciences—Part I" by Alexander Klemin, Aeronautical Consultant

and

"Designing Secondary Power Sources and Mechanisms for Airplanes" by John H. Meyer, McDonnell Aircraft Corporation

The Design Engineer's Role in Airplane Cost Reduction

HORRELL GUSTAVE ERICKSON*

Luscombe Airplane Corporation

THE ENGINEERING PROFESSION rightly can be proud of its contribution to the advancement of aeronautical science during the war. Although necessity dictated emphasis on military characteristics, many of its war-born developments have been or can be adapted to civil aircraft design. Since such military developments are directed toward realization of the ultimate in performance, it is understandable that these may have disregarded the normal economic forces in many respects. This fact, then, will serve to limit use of certain advanced features in the smaller personal aircraft for some time. It has, however, served as a challenge to engineers to devise ways and means of accomplishing the same objectives or results without contributing to the cycle of higher cost, higher price, reduced market, etc.

In this connection, it has been my impression that aeronautical engineers have, even before the war, lacked a full realization of the important relationship between design complexity, product price, and market. All too often we have concerned ourselves solely with detail design compromises with no consideration of the effect of the decision on production expense. This condition has retarded full and sound expansion of the personal aircraft industry by maintaining high costs and prices. Although there might have been some disagreement on this position previously, I believe we will now find general concurrence that the industry must exert every possible measure to provide a product with greater utility at lower cost. Nontechnical management of the personal aircraft companies in the past has seldom questioned the necessity for complicated structures released to the Production Department. Shattering of the calm complacency of the 1946 personal aircraft industry has dictated a careful review of all activities to determine a basis for improving operating efficiency and, hence, reducing costs. This paper will review the role of the airplane designer in this program and highlight the various means available to the engineer to simplify airplane construction and to substantially lower production costs.

It has been generally concluded that mass production is the answer to low prices. This is only partially true, as has been demonstrated by automotive and other mass production industries since the war. It is reasonable to assume that, if a modern personal airplane were completely designed for mass production and placed on the market at substantially lower prices than are now prevalent, the increased sales would fall far short of defraying the expense of redesign and tooling. It should, however, by clever redesign and by tooling in proportion to the market now available, be possible to encourage healthy growth of this market while operating on a profitable basis. This problem, then, is to analyze the overall picture of design, tooling, fabricating, and sales and to determine the course that will best ensure maximum realization of the objectives and benefits of mass production without all of the exorbitant costs of establishing a mass producing system. If we can achieve with relatively simple tooling and facilities only 50 per cent of the economies inherent in a true mass production system, we can reduce the price to a range that will attract a greater number of owners who can profitably utilize conventional personal aircraft. This larger market will, in turn, substantiate more advanced tooling and production systems and also the cost of research and development on new designs.

When we stop to analyze all of the variables that contribute to airplane costs, it is interesting to note the number of such variables directly or indirectly related to the efficiency of our design Engineering. Design Engineering encompasses more than purely technical consideration: It extends into certain phases of almost every function of a modern manufacturing organization; hence, it calls for closest coordination and cooperation with all of the various departments. Knowledge of current problems, activities, and opinions of Purchasing, Material Control, Tooling, Production, Inspection, Sales, and Service personnel is essential to the development of efficient design. It has been said that there are innumerable ways to "skin a cat"; hence, we will, for the moment, disregard primary design problems and assume that a workable technical solution is available in each case. Let us turn to an enumeration of some of the most important practical nontechnical factors that must be considered in any design program directed toward maximum production economy.

(1) Material cost and availability in various forms (including purchased parts).

(2) Type of equipment available (and relative utilization).

(3) Type of personnel and skills required.

(4) Nature and extent of tooling required.

(5) Probable number of units to be produced.

(6) Inventory on hand subject to use or obsolescence.

* Structural Engineer.

(7) Number of pieces and parts involved in design.
(8) Capital available to underwrite costs.
(9) Special requirements established by Management.

In initiating a new design where production cost is a factor, no variable is too insignificant for consideration. The general problems should all be investigated and evaluated at the outset before any attempt is made to begin the actual design. Consideration of current prices of all raw materials in all available forms will come under this general classification.

If current price listings are all assembled for evaluation, comprehensive comparisons can be made in determining the best course for realization of maximum production economy. This information may influence the final decision as to whether the component will be cast, stamped, forged, extruded, or formed from sheet stock. Cost comparisons of the various material forms can be of considerable value in this respect. Also, the indirect problem of balancing cost against weight can be solved on a more sound basis when all the facts regarding relative cost of various materials is available.

Now that the type and amount of production equipment in most aircraft plants are more stabilized than they have been in the past, efficient use must be made of equipment on hand, unless, of course, there is justification for further procurement. To do this efficiently, we must assemble cost breakdowns that are complete in that they include amortization of the original cost of the equipment, as well as the maintenance and operational expenses involved. I believe it has been, or is, the practice of most companies to charge off the first two of these items to overhead without consideration of cost breakdowns, a policy that can obviously lead the designer to false conclusions of economy. Caution must be exercised in considering exact breakdown figures, because overloading of equipment showing the least operational costs can result unless close contact is maintained with the Planning Department on schedules.

Even the subject of personnel enters the picture in designing for economy. Current labor conditions are reflected in the various cost breakdowns, but the type of personnel to be involved is peculiar to the locality and may establish trends toward which many of the components should be designed. For instance, in the East, skilled machinists are more plentiful than in other sections of the country, and knowledge of this fact will influence a design program accordingly.

Next, there are tooling considerations. The size of the tool design staff and the amount of tool and die equipment and skilled personnel available will all have their effect on the design program. If only a short time can be allocated to tooling the project, then due consideration must be given to temporary, as well as long-range, tooling. The extent of the tooling program is, of course, directly connected with the total probable number of units to be produced, and it would certainly take a magician to arrive at anywhere near an accurate figure these days. Some figure, however, must be estimated for use as a guide, and it would be wise to establish it conservatively, since the tooling expense must be written off against it.

Some of you may wonder how the previously mentioned inventory on hand can effect the design program. This is simple when one stops to consider that stock on hand is available immediately for use. Also, there may be overstock that must sometimes be utilized to preclude a loss by sale at less than cost.

The number of pieces and parts involved in a design and production program should warrant considerable discussion but will only be highlighted at this time because of limited space. There should, of course, be made first an estimate as to the total number of parts expected, to serve as a basis for scheduling the various phases of the experimental program. However, in the interest of economy, let us see what happens if the total number of parts required in a finished design is greater than it actually need be. First, there will be more engineering time required because of an increase in the number of drawings and detail design problems. Second, more tooling will be necessary and, consequently, time required to tool up for production. Third, more floor space will be involved. Fourth, more equipment for fabrication will be necessary, and, fifth, most important will be an increase in fabrication time of every unit produced. From the foregoing, it appears, then, that considerable effort should be expended on the part of the designer in keeping the number of parts to a minimum.

Knowledge of the capital available to underwrite the cost of the program is obviously necessary. It is mentioned primarily to point it out as the factor governing the extent of time and financial consideration that may be allocated to research.

Since management is responsible for directing the flow of company finances, it is certainly entitled to establish any special requirements it believes to be beneficial to the company's welfare. It is our duty, then, to see these requirements and company policies are given consideration in the projected design.

So much for generalities. Let us now be more specific and review some of the ways and means at our disposal by which we can accomplish our purpose. In general, they may be listed as follows: (1) subassembly practice; (2) redundant structures; (3) automatic machines; (4) low-density materials; (5) detail design considerations; and (6) interdepartmental coordination.

The principle of subassembling is not new and has always been considered in the design of aircraft structure. However, it is a powerful factor from an economic standpoint, and its importance cannot be overemphasized. Elaboration to the extent it deserves is not within the scope of this paper but it may be well to mention some of its less obvious advantages. First, its adaptability to use of automatic machines can effect considerable savings. Extensive use has been made of subassemblies in this respect in fabrication of the wing shown in Fig. 1, and the results have been grati-

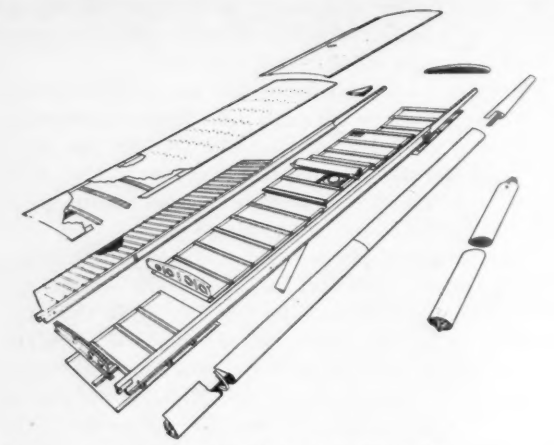

FIG. 1. Silvaire wing and strut assembly.

fying. Second, the improvement in accessibility by subassemblies offers a material saving in that the cost of driving each rivet will be reduced accordingly, whether it be driven by hand or automatic machine. Third, use of this principle affords employment of nonskilled labor in fabrication of some assemblies which otherwise would require skilled labor if the breakdowns could not be so divided.

There is often the possibility of taking advantage of the inherent redundancy in a structure by increasing the gage of the material in structure dictated for other reasons and omitting the direct load-carrying components. This would correspond to a case where the poorly informed designer did not know that it could not be done, so he went ahead and did it anyway. If standard practices and rules of engineering were to be strictly adhered to, the final price of personal aircraft would necessarily be based upon the same cost per pound as larger and more complicated airplanes. Needless to say, few personal airplanes would be sold to individuals if this ratio were maintained. An example demonstrating simplification by use of redundant structure can be found in Fig. 2. Here the leading edge structure and main skins were already dictated by aerodynamic requirements. By increasing the gage of the leading edge skin from 0.020 to 0.040, it was possible to omit the main spar, thus improving accessibility, as well as saving the entire cost of the part, its design analysis, tooling, fabrication, and assembly.

Another item in need of investigation is the practice of transferring loads by concentration of applied loads at a particular point, effecting a transfer of the concentrated loads and, subsequently, expanding them again in the adjoining structure. Usually, we have laid justification of this type of joint to service facility, when actually the only reasons have been force of habit. It has been our policy to avoid this practice, since we have proved to our own satisfaction, and I believe most of you will concur, that it is economically more sound to transfer loads in their expanded form.

As already mentioned, we can obtain further economy by making the most of the automatic machines that may be available. Experience has proved that the cost of automatic riveting and spot-welding is considerably less than the cost characteristic of hand-driven rivets. This difference can justify expenditure of considerable effort on the part of the designer toward further extension of their use. Some of us have also been guilty of ignoring the advantages obtainable in designing parts for fabrication in automatic screw machines. If the number of parts required is sufficient to justify an initial setup, we should not forget that the cost per part will be only a small fraction of that peculiar to manually operated machines.

A discussion such as this would not be complete without considering the possibilities that may exist in the use of low-density material. There are several cases on record where magnesium alloys have been employed for primary structure at a substantial reduction in overall costs. Since these alloys are the most expensive in the lighter gages, however, it would probably be difficult to justify their use in other than heavy-gage construction. I can cite at least one typical case where a saving in overall cost of 40 per cent was realized along with many other advantages not in keeping with this discussion.

As far as I know, the use of plastics has as yet been limited, but, since there are on record a few cases when appreciable savings have been claimed by the designers, we should not overlook any possibilities that may exist in this field. Little can be done as yet, however, until service records are complete.

Knowledge of the foregoing methods and principles will be of little benefit if due consideration is not given to the detail design features of each component. The old saying, "It's the little things that count," will certainly hold true in this respect. It is the practice of many designers to leave the nasty details up to the draftsman, when often the details themselves can make the design either a success or failure economically. If for lack of time on the part of the designer this practice

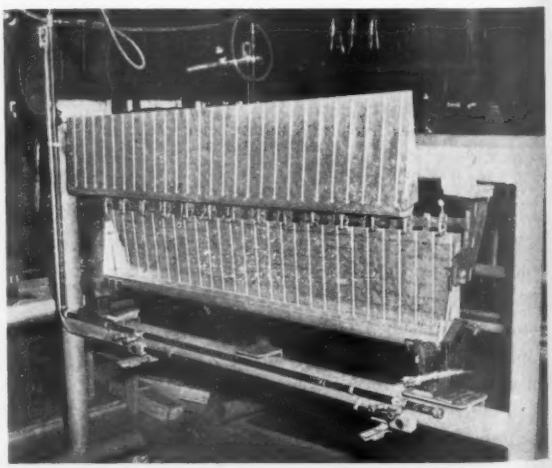

FIG. 2. Four-place airplane all-metal aileron.

must be continued, there should first be made an honest effort to educate the draftsmen along lines of design and production economy. The application of this corrective measure, however, should not mean that we are relieved of our responsibility for continued attention to the design details. Any disagreement here can easily be expelled by reviewing some of the items that should be considered after a layout has left the hands of the designer to be detailed and released for production.

One of the first possibilities is the elimination of left- and right-hand parts, which may be accomplished in at least the blanking stage if not in the finished form. Probably the best method of emphasizing the importance of this seemingly small matter would be in discussing the advantages obtainable costwise.

For one, there will be less tooling to write off against the part, and, unless the number of units to be produced is larger than the present market might indicate, this fact cannot be entirely ignored. Another is that of lower inventory in both raw stock and finished parts that must be kept on hand. The savings thus realized are indirect, but are they not just as important in the overall picture?

Further, if the total number of different parts released to the Shop can be reduced, the waste and salvage will be reduced accordingly.

Another item of no less importance is the saving in drafting and clerical work. It might appear to some that this is drawing the line too fine, but nevertheless, this fact has been proved to merit consideration. It does not seem so strange when one considers that fewer drawings mean considerably less prints to be maintained and distributed, thus resulting in less filing at all plant stations. Individually, these items may not amount to a great deal, but they all aid in lowering the plant overhead.

Still another means for economical design lies in the combination of parts. There is the possibility of one part being made to do the work of more than one by addition of one or two operations. The cost of a subsequent operation to one part is considerably less than that of two different parts requiring the same number of operations. The automotive industry has recognized this fact and adopted this practice years ago, but, for some reason, aircraft designers have been reluctant to specify more than one or two operations on a single part. If the cost of aircraft structure is to be reduced, the number of parts must be kept to a minimum.

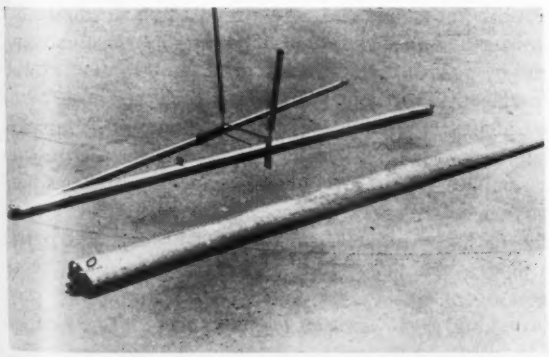

FIG. 3. Silvaire original and redesigned strut assemblies.

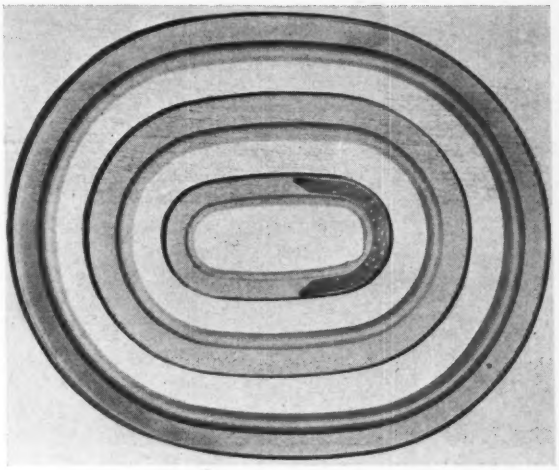

FIG. 4. Silvaire tail cone bulkheads.

Another method of reducing overall costs is relaxation of tolerances. There has always been a tendency for designers to assign standard close tolerances without further consideration. Unnecessarily close tolerances can complicate operations required to fabricate even simple parts and frequently require additional operations not specified on the drawing. Quite often, welded assemblies may require machine operations not specified to meet even standard tolerances. In Fig. 3 is shown an example where the necessity for close tolerances was virtually eliminated in the redesigned counterpart. It was primarily for this reason that the use of a single strut was chosen in lieu of "V" struts with jury bracing. With the single strut, slight variation in length is of little consequence, and any misalignment in the end fittings can be absorbed by a universal joint at the fuselage connection. If a joint must be designed for bolts, it is better to use only one, if possible, in order to eliminate the tolerances that must be held to match the mating part.

Relaxation of tolerance can allow greater versatility in manufacturing methods. Wide tolerances can permit a job to be handled by any one of several machines, whereas, restriction to any one tends toward waste of both planning and shop time. There is also the fact that less time will be required to complete each operation if the Shop is not bound by close dimensioning. Less-skilled workers may then be qualified to handle the job. Jigging and tooling need not be so elaborate and can be accordingly less expensive. Again, there will be the possibility of reducing loss by salvage.

Much lost motion and time can be eliminated in Planning and in the Shop if alternate materials and methods of joining are specified on drawings. The greatest saving will be realized in the nonstructural

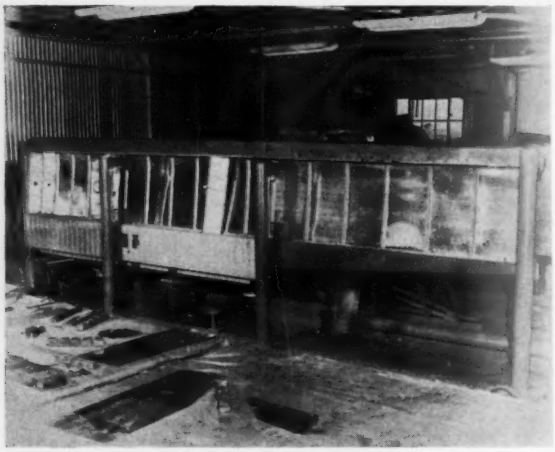

FIG. 5. Four-place airplane all-metal wing.

parts by permitting usage of odd-lot materials. The same reasoning also applies to castings, in that local sources may often be obtained at a reduced cost if material requirements are not too stringent. Even the item of material waste should be considered in the design stage. Every designer knows that straight shearing operations are less expensive than routing or blanking of parts, and recognition of this fact can serve a useful purpose from the very outset of the design to the last detail. The problem of waste was nicely handled in the designing of the fuselage bulkheads shown in Fig. 4, where a large portion of one ship set of bulkheads is obtained from a single sheet.

Decreasing the number of parts is probably by far the most effective means of cutting manufacturing costs. It is by no means easily accomplished, however, and only by valiant effort and display of ingenuity can the designer expect to arrive at an optimum in this respect. Elimination of only a few parts can do much toward reducing overall costs, since the subsequent effect is to decrease work in all departments.

There has always been a gap between Engineering and Production which, to my knowledge, has attracted insufficient attention but which appears to hold worthwhile possibilities for increasing efficiency. The larger companies are more guilty of insufficient coordination in this regard. It is understandable in one respect, since the individual responsibilities of their personnel are more limited by specialization. On the other hand, there seems to be no reason why special positions cannot be established for personnel in each department to coordinate with the designer their respective departmental functions. It is impossible for any one person to design completely a component from the beginning to the production article and foresee all the difficulties that will be encountered in planning tooling, jigging, and production scheduling. Why, then, have we been following this practice? Since all these departments are affected, should not they have the privilege of voicing their opinions and airing their problems? We contend that only through continuous close cooperation with specialists from each department involved can the optimum in design be reached costwise. It has been our experience that estimation as to method of handling in production is unreliable, since there are too many unforeseen problems arising in the other departments of which the designer has no time to keep informed. One of these problems could be in overloading of particular pieces of equipment. Only Planning would be in a position to know the answer to this one.

Now that we have reviewed some of the tools with which the designer has to work, it may be of interest to see how some of these principles have been applied. In Fig. 5 is shown a wing of a personal airplane, the design of which has been based on these principles. This type of structure permits the use of exceptionally wide tolerances. The use of automatic riveting machines was introduced in fabrication of the skin panels. Approximately four-fifths of the total number of rivets in the wing are driven in this manner. In the case of the apron strips, cost was given preference over weight, in that they could have been scalloped. The spars are extruded from 61 ST material chosen because of its lower initial cost. Cost analysis was made of the same section formed from sheet stock, but the results favored extrusions by a considerable amount. 61 ST material also possesses good corrosion resistance.

The wing formers are cut from strip stock and fabricated on a single-operation die. Joints in all cases are riveted, precluding the need for close tolerance holes or matched hole patterns required for bolts. In the wing plan form and cross section, aerodynamic concessions were made allowing standardization of all upper and all lower formers. The overall setup was designed with considerable thought being given to minimizing tooling and jigging problems. Plan form and controlling points of a previous design were retained to permit use of jigs and tooling already fabricated. Even the amount of floor space necessary for fabrication of subassemblies was included in the design considerations. The lack of full-depth ribs minimizes the number of joints to be matched and assigns little restriction by tolerances. The tip is fabricated by drawing a single sheet and is attached to the wing by rivets around the periphery. The use of a single extruded strut was chosen to minimize tolerance requirements. As already mentioned, variations in length cannot cause binding, and any misalignment can be absorbed by the universal joint located at the fuselage. The stamped steel fittings riveted in each end are identical, eliminating the need for right- and left-hand parts and, consequently, right and left strut assemblies. Since, in our plant, welding and machining are costly operations, special attention is given to the exclusion of welded structure and machined parts.

The aileron shown in Fig. 2 may be of interest because of its lack of internal structure. Two ribs, two skins, a "U" section leading edge, and a stamped horn comprise the entire assembly. Characteristically, the static underbalance is small, the heavy part of the

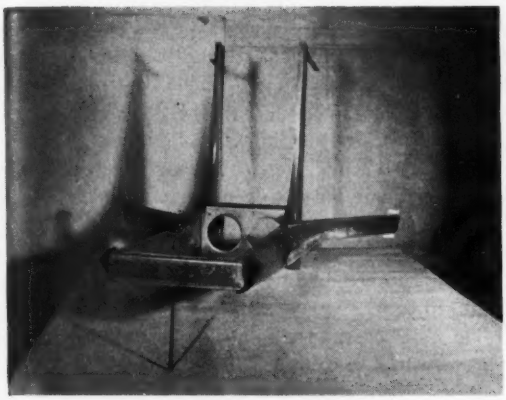

FIG. 6. Sheet-metal engine mount for 165-hp. horizontally mounted engine.

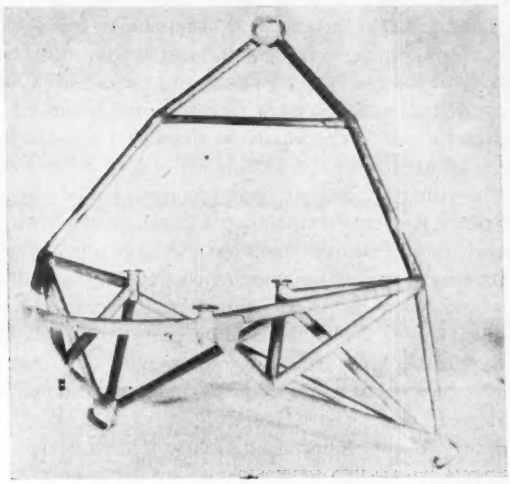

FIG. 7. Tubular engine mount for 65-hp. horizontally mounted engine.

structure being forward of the hinge line. Elaborate aileron and wing jigging was eliminated by use of two self-aligning bearings mounted at the extreme ends. This type of construction allows use of extremely wide tolerances with maximum accessibility even to the extent of permitting assembly on automatic riveting machines.

The principles of structural simplification and cost reduction are reflected also in a new engine-mount design. Our diversion from the normal approach of using welded steel tubing structure yielded rather surprising results both costwise and weightwise. The conventional welded tubing design was discarded in lieu of aluminum-alloy sheet-metal stampings, effecting elimination of all hand-welding operations and machining. The mount shown in Fig. 6 will accommodate a 165-hp. engine at a weight penalty of 10 lbs., while the conventional design shown in Fig. 7 will accommodate only 65 hp. at almost the same weight. Cost analyses of the two mounts disclosed the cost of the larger mount to be slightly over one-third of that of the smaller conventional counterpart. It might be well to point out that in this case engine-mount loads are transferred to the fuselage structure in expanded form. Note that bolts, bushings, and matched holes necessary in transferring concentrated loads would have increased the cost of this mount considerably.

A case of redesign for more economical fabrication is always educational, in that we have a basis for comparing results. It also helps to inflate one's ego when and if satisfactory answers are obtained. The empennage assemblies shown in Figs. 8 and 9 are illustrative of such an example. Although the original surfaces were by no means the most efficient of conventional structures, they are believed to be sufficiently representative to serve as an approximate basis for comparison. First, the redesigned surfaces require but little more than one-half of the number of rivets for fabrication as required by the original counterparts (actual reduction in stabilizer—450 rivets). All opposite parts were eliminated, permitting use of a single piercing die for each part. Second, with the

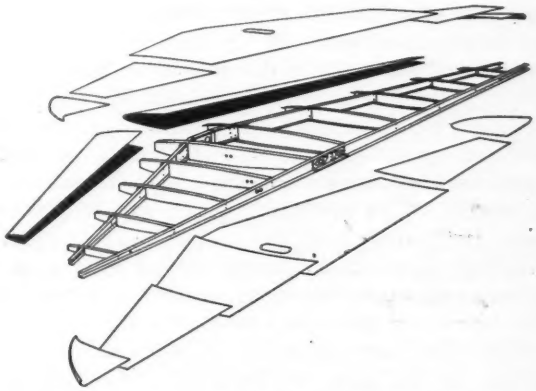

FIG. 8. Silvaire original and redesigned stabilizer.

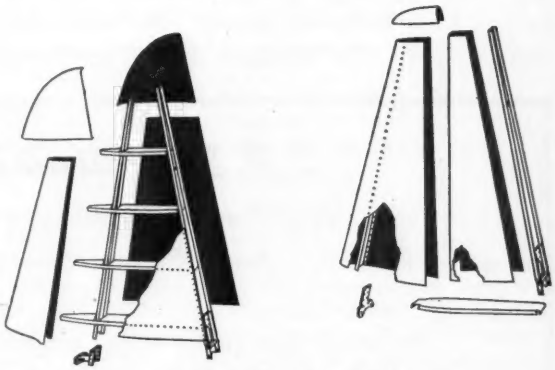

FIG. 9. Silvaire original and redesigned fin.

exception of the ribs, fuselage attaching fittings, and the stabilizer leading edges, all parts may be sheared to size. Third, brakes may be used in forming of all parts except the ribs and tips, thus requiring but little tooling. Fourth, only a single draw die is required to form the tips, since they are identical for both

surfaces. Fifth, hinges are standardized for both surfaces. Sixth, the excellent accessibility for fabrication permits ease of riveting and inspection. Just as a matter of interest, the elevators and rudder used with the original surfaces were retested and found to be satisfactory with the auxiliary spars and one-third of the total number of rivets removed.

Unfortunately, we also have to have landing gears. At times it seems ironic that a machine designed to operate in one medium must have so large a percentage of its weight and manufacturing cost tied up in making it adaptable to another. However, it seems to be a necessary evil; and since landing gears do represent a fairly sizable proportion of our weight and cost, I believe it is worth while for me to make mention of the work we have done with them.

First, we have minimized this weight and expense as much as possible at the outset by using only fixed conventional gears. Up to 1947, the Silvaire landing gear had been in use without change for many years. It was then examined with a view toward simplification and cost reduction. We were then using a single shock absorber mounted under the floor of the fuselage in the center and with both legs hinged thereto. This unit was simple as far as it went, but we have gone a little further. The original cylinder was made of standard tubing welded to an end plate, or cap, and with fittings welded on to that. Of course, the whole mass distorted during welding, so it had to be machined afterward. This has been replaced with a cylinder made from tubing purchased to close inside tolerances and furnace brazed to a forged end cap with integral fittings. The only machining required is cutting off the tubing and threading one end for the piston retainer. The inside diameter as purchased is close enough for the piston and for a tight fit on the end cap. The brazing produces no distortion. The piston is also of two-piece construction—the rod and piston cap. These are simple machine parts with reasonable tolerances furnace-brazed together. The former units were of welded construction and required machining after the welding and selective fitting to the cylinders. The piston itself is not sealed. We use a simple dodge, well known in the oil fields, to control leakage past the piston rather than to stop it. This controlled leakage acts as part of our orifice area and gives consistent results over a range of diametral clearance in cylinder of 0.002 to 0.012 in. We also use an "O"-ring retainer packing requiring only a one-piece retainer nut instead of the two-piece device with two sets of threads required with our former chevron packing. This unit provides improved taxiing and landing characteristics at reduced cost. I recall that at a previous Institute meeting we discussed the relative merits of spring oleos versus air oleos. It is probable that we could save a couple of pounds by throwing out our heavy coil spring and going to a high-pressure oil air strut, but I do not believe we could even begin to approach our present cost with such a design, to say nothing of the maintenance problems.

Now for the landing gear legs. Our former design involved a tripod arrangement with streamline tie rods for the inner members and tubular steel struts. This was redesigned to eliminate the tie rods by using step tapered tubing for the main legs. Insofar as the gear is concerned, we could also have eliminated the drag legs, but this would have called for major redesign of the fuselage structure, so we have retained a simplified and stronger version of the drag strut. In accomplishing this redesign, we simplified all fittings as much as possible and succeeded in eliminating a large portion of the welding and in reducing our overall cost by a substantial amount.

The foregoing has been offered to stimulate recognition of the need for low-cost, low-priced personal airplanes and also, to emphasize, as well as review, the design engineer's role and his contributions toward attainment of this goal. If we all recognize this present deficiency and work together, we can, by making it possible to lower prices, extend the personal airplane market and ensure healthy growth of personal airplane industry.

I.A.S. National Meeting Schedule

Flight Propulsion Meeting—Hotel Carter, Cleveland—March 19

Annual Summer Meeting—Los Angeles—July 15–16

Members or organizations wishing to submit papers for presentation at National Meetings should send outlines or summaries to the Committee at least 3 months prior to the meeting.

All papers submitted will be considered for publication in the *Journal of the Aeronautical Sciences* or the *Aeronautical Engineering Review*.

All correspondence should be addressed to The Meetings Committee, Institute of the Aeronautical Sciences, 2 East 64th Street, New York 21, N.Y.

I.A.S. Briefs

Summaries of current papers received for publication or presentation at I. A. S. meetings

Many of these papers, after being processed by the Editorial Committee in the usual manner, will appear in full in later issues of the JOURNAL *or* REVIEW.

Preprints of these papers are not available at this time.

Inelastic Column Theory and Analysis of Experimental Observations*

By

Chi-Teh Wang

New York University

The inelastic column buckling theories as usually presented are found to be rather confusing. Many experimental results still cannot be explained satisfactorily by the theories as they stand. It appears to be pertinent, therefore, to define the inelastic buckling problem once more from a more rigorous mathematical point of view and to give a more rigorous mathematical treatment of the problem. The effect of assuming a constant tangent modulus on the buckling load in the tangent modulus formula is discussed, and many anomalies of column behavior in the inelastic region are explained.

In making such a study, it is important to emphasize the difference between an ideal column and an actual column and the difference between the buckling load and ultimate load. Southwell's method for analyzing column tests, which was originally proposed for the case of elastic buckling, is now shown to be valid for inelastic buckling. It is also shown that, in applying the method, instead of analyzing load and deflection measurements, simultaneous load and strain readings can be used. Thus, it is easier to measure the strain more accurately.

* Accepted for publication in the JOURNAL.

Low-Speed Flutter and Its Physical Interpretation*

By

M. A. Biot and Lee Arnold

Brown University and Aeronautical Consultant

The phenomenon of low-speed flutter of an oscillating airfoil is investigated. The problem resolves itself into the study of two phenomena: that of zero air-speed classic flutter, and that of an oscillating airfoil with no vortex shed. It is seen that both cases involve oscillation of the airfoil about a nodal line located three-quarters of the chord aft of the leading edge. The study is based on the fundamental theory developed by Theodorsen.

The relationship between the parameters required for zero-speed flutter for the general case is developed, and the physical interpretation of this phenomenon is discussed.

For the latter case, the solution of the equations of motion, based on noncirculatory flow, and the equations resulting from the Kutta condition results in a relationship between the inertia and elastic parameters for which the airfoil will flutter (i.e., maintain oscillations at constant amplitude) for all air speeds. The physical interpretation and the mechanism of this phenomenon are discussed.

Practical implications, such as the importance of nodal line location and the effect of the physical parameters of the airfoil on nodal line location, are discussed.

The possibility of a new approach to the flutter problem is suggested—that of employing the ground vibration modes of the airplane to study the existence of a low flutter speed and as a design guide to raise the flutter speed.

Conclusions are also drawn regarding the influence of aspect ratio and the relative importance of theoretical aerodynamic coefficients against values of these quantities measured in the wind tunnel.

* Accepted for publication in the JOURNAL.

Static Thrust Analysis for Helicopter Rotors and Airplane Propellers*

By

Walter Castles, Jr., and Arnold L. Ducoffe

Georgia School of Technology

This paper presents a solution for the relation between the blade angle, thrust, and torque coefficients of a helicopter rotor in hovering flight. This analysis presents the case wherein the induced velocity at a given radius, R, is set up as a function of the thrust at that radius, and a semiempirical constant, K_1, is introduced to account for the viscous shearing forces in the flow. Equations have been derived which yield, upon graphical integration, the thrust and torque for the general case of blades with any solidity, twist, or taper. The solutions for the integrals of the equations for the special case of a constant chord, untwisted blade are also presented. The results apply to a helicopter operating in or out of ground effect, and values of the semiempirical constant, K_1, which have been calculated from experimental data, are presented for

* Accepted for publication in the JOURNAL.

the entire range. This method gives values of the thrust and torque coefficients which are in good agreement with the available experimental data. Since the static thrust case of an airplane propeller is identical to that of a helicopter rotor in hovering flight, this method can be used for the calculation of the static thrust and torque of modern variable pitch propellers.

An Analytical Study of the Landing Shock Effect on an Elastic Airplane*

By

R. H. Scanlan

Rensselaer Polytechnic Institute

Several authors have considered the analytical problem proposed in this paper: Given the time history of the forcing functions (from theory or test experience) applied to the main landing gear in vertical and drag directions during landing of an airplane, and assuming the airplane elastic, describe the various accelerations of its components.

* Accepted for publication in the JOURNAL.

The solution presented here contains new features, some or all of which have been neglected by others. These are:

(1) The inclusion of a sufficient number of degrees of freedom adequately to describe important observed effects of actual landings. Such effects are exemplified by the "whipping" of landing gear, fuselage, and tail surfaces (occasionally of enough magnitude to cause failure).

(2) The use of normal coupled vibration modes of airplane components as generalized coordinates.

(3) The inclusion of the effects of structural damping throughout the complete time interval considered.

The detailed motions of individual components in their proper phase relation to the other components of the structure are also considered. Of interest to the designer is the fact that overconservative practices, such as the superposition of maximum effects, are avoided in the present analysis.

The equations of motion developed here are fairly numerous. Since the forcing functions are not analytically prescribed, the solution of the equations of motion is lengthy, though straightforward, by conventional approximate means. Use of a differential analyzer on the problem would, of course, be desirable, but the solutions are presented here in a way that is suited to approximate calculation by hand methods.

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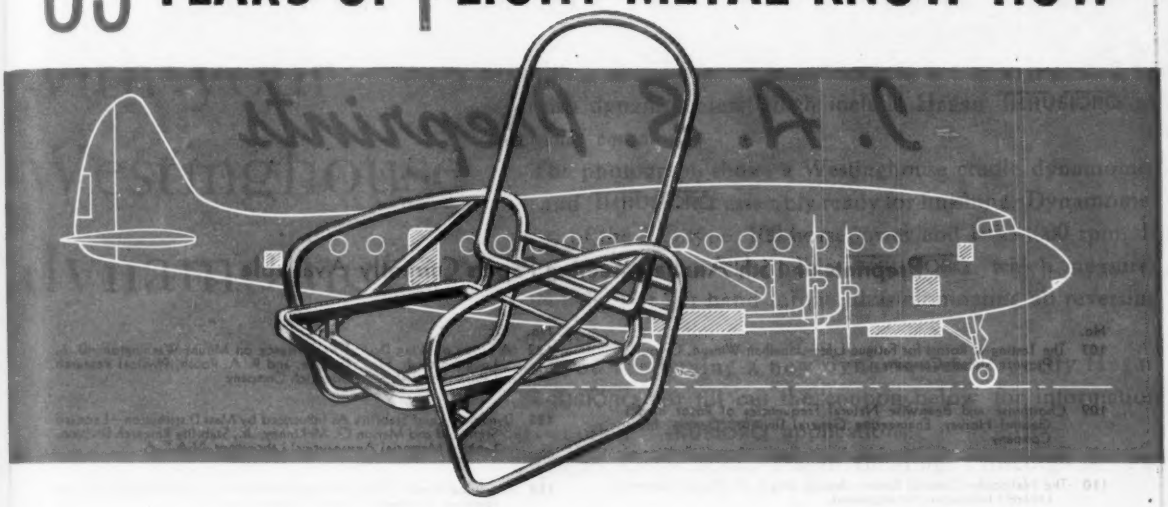

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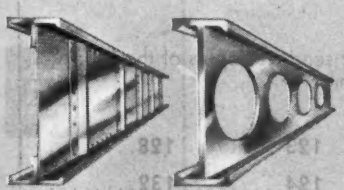
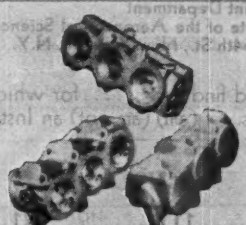


Perhaps the use of EXTRUDED MEMBERS can eliminate assembly costs and cut down weight.



Or the use of FORGINGS can lower machining costs and reduce weight.

I. A. S. Preprints

Preprints of 16th Annual Meeting Papers Currently Available

No.

107 The Testing of Rotors for Fatigue Life—Jonathan Winson, Consultant, Prewitt Aircraft Company

109 Chordwise and Beamwise Natural Frequencies of Rotor Blades—Gabriel Horvay, Engineering General Division, General Electric Company

110 The Helicopter Control Rotor—Joseph Stuart, III, Project Engineer, United Helicopters, Incorporated.

114 Application of the Performance Operator to Aircraft Automatic Control—R. C. Seamans, Jr., Director, Tracking Control Project, Massachusetts Institute of Technology; B. G. Bromberg, McDonnell Aircraft Corporation; and L. E. Payne, Jackson & Moreland

117 N.A.C.A. Investigation of Gas-Turbine Blade Cooling—H. Ellerbrock, Flight Propulsion Research Laboratory, N.A.C.A.

118 Problems of Gas-Turbine-Propeller Combinations—Frank W. Davis, Assistant Chief Engineer, Consolidated Vultee Aircraft Corporation

119 The Automatic C-54—James Anast, All-Weather Flying Division, Air Materiel Command

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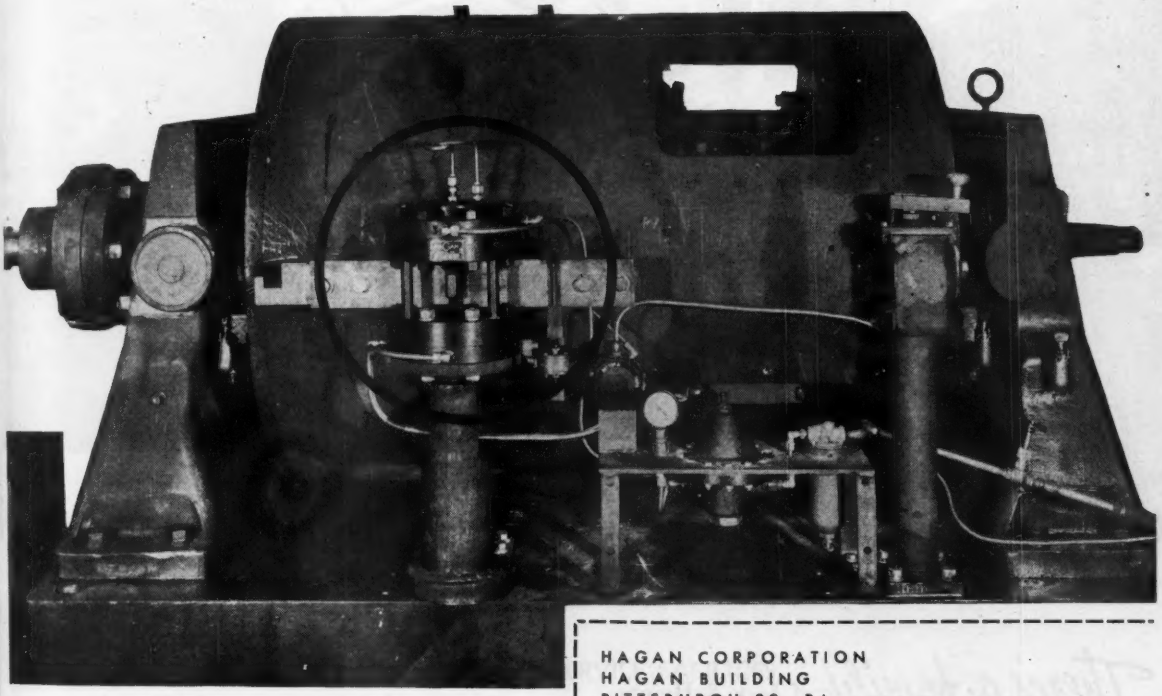

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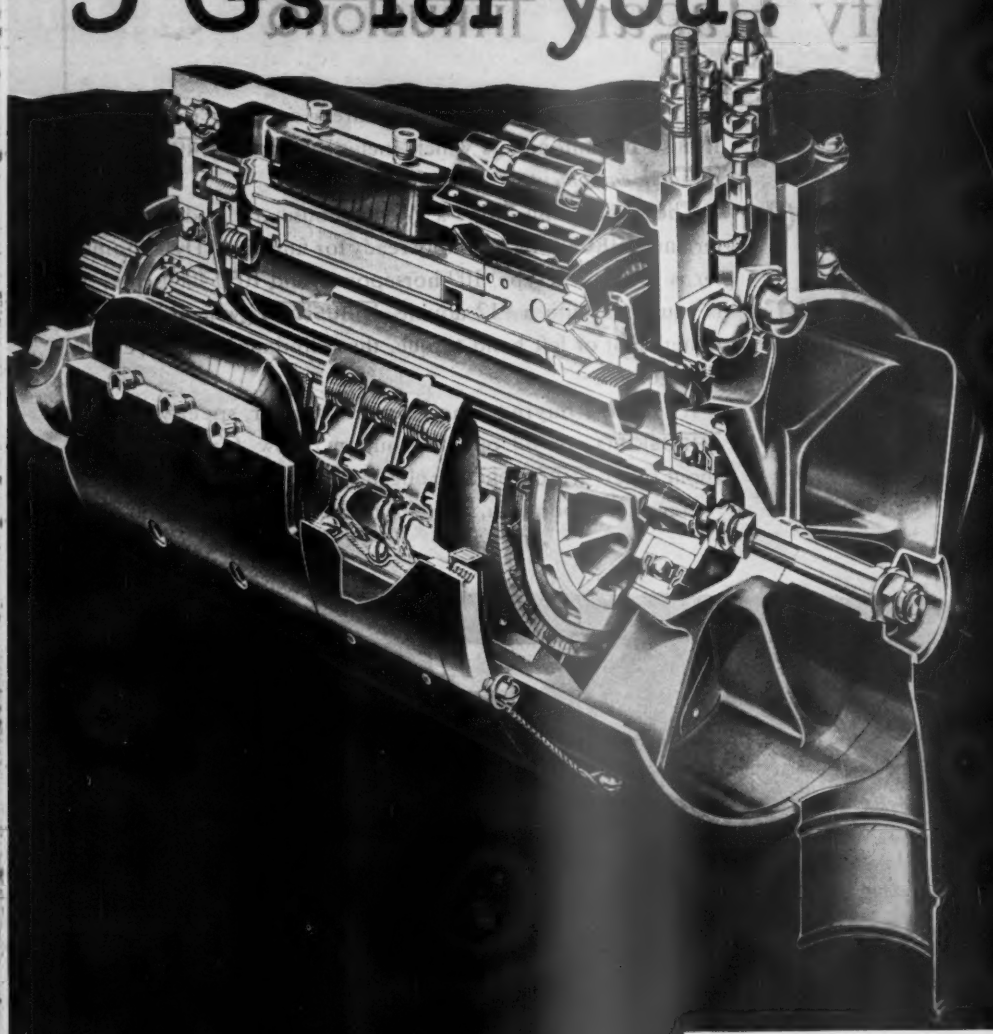

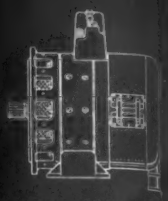

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Aerodynamics

CONTROL SURFACES & AUXILIARY DEVICES

Russian Laminar Flow Airfoils. III—Measurements on the Profile No. 2315 Bis with AVA-Nose Flap. F. Riegels. (*ZWB/UM/3607*, January 17, 1944.) *U.S., N.A.C.A., Technical Memorandum No. 1127*, September, 1947. 25 pp., diagrs. 4 references.

Wind-tunnel measurements to determine the effect of Göttingen nose flaps on the maximum lift coefficient of airfoils with small nose radii indicated that the increase in the lift coefficient would be considerable even for small flap chords.

Measurements in Flight of the Stability, Lateral-Control, and Stalling Characteristics of an Airplane Equipped With Full-Span Zap Flaps and Spoiler-Type Ailerons. J. Richard Spahr and Don R. Christopherson. *U.S., N.A.C.A., Memorandum Report (Wartime Report No. A-28)*, December, 1943. 98 pp., fold. charts. 4 references.

Wind-Tunnel Investigation of a Beveled Aileron Shape Designed to Increase the Useful Deflection Range. R. T. Jones and W. J. Underwood. *U.S., N.A.C.A., Memorandum Report (Wartime Report No. L-651)*, April, 1944. 16 pp., diagrs. 3 references.

Wind-Tunnel Investigation of Ailerons on a Low-Drag Airfoil. II—The Effect of Thickened and Beveled Trailing Edges. Robert M. Crane and Ralph W. Holtzclaw. *U.S., N.A.C.A., Advance Confidential Report No. 4A15 (Wartime Report No. A-54)*, January, 1944. 50 pp., illus. 6 references. (Cf. AER 1/48:34.)

Wind-Tunnel Tests on the Ailerons of E.6/41. A. S. Halliday and D. K. Cox. *Gt. Brit., Reports and Memoranda No. 2185*, August, 1943. 20 pp., figs. British Information Services, New York. $1.20.

FLUID FLOW

The Boundary Layer of Yawed Cylinders. W. R. Sears. *Journal of the Aeronautical Sciences*, Vol. 15, No. 1, January, 1948, pp. 49–52, figs. 5 references.

Starting with the Navier-Stokes equations of motion for viscous fluids, Prandtl's argument regarding the orders of magnitudes of quantities in a laminary boundary layer is repeated for the special case of a yawed cylinder of infinite length. It is shown that for this case the chordwise flow is given by the same equations as for unyawed (plane) flow about the same cylinder and that the spanwise boundary-layer flow can be calculated by integration of a linear second-order differential equation. This result leads to useful conclusions—e.g., that the location of laminar separation of the chordwise flow is independent of yaw. As an example, the flow over a flat plate, at zero incidence, having a sweptback leading edge is treated. It is found that the boundary-layer flow is always in the direction of the external stream and has the Blasius velocity profile—i.e., it is unaffected by sweepback of the leading edge. As a second example, a certain class of cylinders suggested by Prandtl is considered in the yawed condition. The flow about these in the plane case is known, the spanwise boundary-layer flow is calculated approximately, and some characteristic features are presented graphically.

The Limiting Line and Its Relation to the Critical Mach Number (Project No. HA-219). Hideo Yoshihara. *U.S., Air Force, Technical Report No. F-TR-1149-ND*, November, 1947. 16 pp., figs. 7 references.

Several exact examples of compressible flows with limiting lines were examined in detail. A clear distinction must be made between the limiting line that occurs with expansion and that which occurs with compression. In the former case, when the limiting line is formed by an envelope of expansion waves, it is not determined entirely by its boundary conditions. By choosing a suitable shape of the walls downstream, continuation of the flow which is physically possible may be constructed into the "forbidden region" downstream of the former limiting line. In the case of the limiting line that occurs in a compression region, the flow is determined fully by the boundary conditions and cannot be continued beyond the line if it is still to remain isentropic and irrotational. However, in all known cases at the instant when the limiting line appears, a point of infinite curvature appears at the boundary. Therefore, if it is stipulated that the boundaries be without discontinuity in the slope of the wall, it may be expected that limiting lines may occur at lower Mach Numbers.

Examples known up to now do not give a conclusive indication as to when the "breakdown" of potential flow occurs in a supersonic region imbedded in subsonic flow .

Shock-Wave and Boundary-Layer Phenomena Near a Flat Surface. A. Fage and R. F. Sargent. *Royal Society of London, Proceedings, Series A*, Vol. 190, No. 1020, June 17, 1947, pp. 1–20, 2 pp. plates. 1 reference.

Shock-wave and turbulent boundary-layer phenomena near the smooth flat metal floor of a specially designed supersonic tunnel are studied from traverses made with pitot, static pressure, and surface tubes and from direct shadow and Topler striation photographs. The shock-wave systems are normal or oblique, with or without a bifurcated foot.

Flow Along Plates and Similar Bodies. G. Flügel. (*Schiffbau*, Vol. 30, 1929, pp. 336–338.) *Cornell Aeronautical Laboratory, Translation*, June, 1947. 8 pp., diagrs.

An investigation to establish mathematical bases from which to calculate the forces acting on plates or similar bodies, rectangular and of other plan forms, both with and without profile drag, which have infinite aspect ratio both normal and oblique to the direction of flow. From these bases the maximum angle of attack can be computed at which the transition from one flow condition to the other is as gentle as possible. The cases of bodies with infinite aspect ratio normal to the flow and oblique to the flow and both with and without profile drag are considered.

New Aspects of Transonic Flow Theory. Gottfried Guderley. *U.S., Air Force, Air Technical Intelligence, Technical Data Digest*, Vol. 12, No. 9, November 1, 1947, pp. 5–18, diagrs. 8 references.

An integration of recent papers dealing with the character of fluid flow in the transonic region. No detailed mathematical development is given, but the phenomena are explained by comparison with similar physical events. The boundary value conditions that must be determined to define a flow, flow behavior during transition from pure to mixed flow patterns, and the pattern caused by perturbations in a mixed subsonic flow are analyzed. These analyses serve as a background for a discussion of the flow pattern about a profile and drag at Mach 1 and critical Mach Numbers.

The Mechanism of Fluid and Air Drag. Th. von Kármán and H. Rubach. (*Physikalische Zeitschrift*, Vol. 13, No. 2, January 15, 1912. pp. 49–59.) *Cornell Aeronautical Laboratory, Translation*, October, 1947. 19 pp., illus.

An exposition of the fundamental mathematical and experimental research by which a stable configuration was determined for the vortex sheet in two-dimensional fluid flow. By application of the momentum principle to this concept an expression is derived for the drag of a body in two-dimensional fluid flow.

On the Kinematics of Turbulence. F. N. Frenkiel. *Journal of the Aeronautical Sciences*, Vol. 15, No. 1, January, 1948, pp. 57–63, figs. 13 references. (*See* AER 7/47:28.)

Decay of Vorticity in Isotropic Turbulence. G. K. Batchelor and A. A. Townsend. *Royal Society of London, Proceedings, Series A*, Vol. 190, No. 1023, September 9, 1947, pp. 534–550, diagrs. 7 references.

The equation describing the rate of change of the mean square vorticity in homogeneous isotropic turbulence is obtained. A negative contribution to $\overline{d\omega^2}/dt$ arises from the effect of viscosity while a positive contribution is produced by the tendency for the random diffusive motion to extend the vortex lines. This latter contribution can be related to the skewness of the probability distribution of the rate of extension of line elements of the fluid aligned in any given direction. The results of direct measurements of each of the factors appearing in the vorticity equation are described. The measurements were made by analyzing electrically the output from a hot-wire anemometer placed downstream from a grid in a uniform stream. Both U^2/u^2 and λ^2 are found to increase approximately linearly with time during decay of the turbulence and their rates of change are consistent with the energy equation. The skewness factor mentioned above is approximately constant during decay, with the same value at all Reynolds Numbers. It follows that the rate of increase $\overline{\omega^2}$ due to vortex extension is proportional to $(\overline{\omega^2})^{3/2}$, and further measurements show that the effect of viscosity has a similar dependence, so that the ratio of the two contributions to $\overline{d\omega^2}/dt$ remains the same throughout the decay. The viscous contribution is always the greater, but the contributions tend to equality as the grid Reynolds Number increases. The meaurements of all terms in the vorticity equation are shown to satisfy the equation with sufficient accuracy. One of the deductions from the measurements is that the double velocity correlation function tends to a cusp at the origin as the Reynolds Number increases indefinitely.

A Study by a Double-Refraction Method of the Development of Turbulence in a Long Circular Tube. A. M. Binnie and J. S. Fowler. *Royal Society of London, Proceedings, Series A*, Vol. 192, No. 1028, December 23, 1947, pp. 32–44, diagrs. 12 references.

A streaming double-refraction method was employed to examine the flow in a long glass tube of a very weak solution of benzopurpurin in water. Two kinds of turbulent entry were used: With one, laminar flow at a Reynolds Number of about 1,900 was observed at cross sections more than 120 diameters from the entry; with the other, the corresponding distance was 90 diameters. The nature of the breakdown of laminar flow at a cross section was found to depend upon the kind of entry and upon the distance of the cross section from the inlet. The development of complete turbulence at various cross sections was also investigated.

Measurements in the Turbulent Wake of a Cylinder. A. A. Townsend. *Royal Society of London, Proceedings, Series A*, Vol. 190, No. 1023, September 9, 1947, pp. 551–561, figs. 6 references.

An experimental study of the conditions in the turbulent wake behind a cylinder in an air stream at cylinder Reynolds Numbers between 100 and 7,000. The measurements include the mean velocity distribution, the distribution of the three components of turbulence, the statistical distribution of time of the turbulent velocity components, and the correlation derivatives in the downstream direction for both the longitudinal and transverse correlations. It is shown that the intensities of the three components of turbulent velocities are nearly equal at the center of the wake, where the balance between viscous decay and diffusion from the regions of shear results in a considerably greater intensity for the component at right angles to the direction of flow and also to the axis of the cylinder—i.e., in the direction of the diffusion of turbulent energy. An analysis of the energy in the wake proves that complete dynamical similarity in the wake, if it is ever attained, does not occur closer to the cylinder than 1,000 diameters and that the viscous dissipation of energy can be described in terms of a length parameter, nearly constant over the width of the wake and approximately equal to the measured value of Taylor's scale of microturbulence.

An Investigation, by the Method of Characteristics, of the Lateral Expansion of the Gases Behind a Detonating Slab of Explosive. R. Hill and D. C. Pack. *Royal Society of London, Proceedings, Series A*, Vol. 191, No. 1027, December 3, 1947, pp. 524–541, figs. 3 references.

An examination by hydrodynamic methods of the phenomena occurring when an uncased explosive charge is detonated in a fluid medium. Attention is focused in the pressure and velocity distributions in the gaseous explosion products. For simplification, the charge and the gas and fluid fields are considered two-dimensional. The equations were solved numerically by the method of characteristics. The methods of numerical integration are similar to those developed for determining velocity distributions around projectiles moving at supersonic speeds.

FLUTTER & VIBRATION

Vibration Surveys of the P-40 Rudder and Fin-Rudder Assembly. Theodore Theodorsen and Arthur A. Regier. *U.S., N.A.C.A., Memorandum Report* (*Wartime Report No. L-652*), April, 1943. 18 pp., illus.

FUSELAGES, HULLS, & ALIGHTING GEAR

A Method for the Calculation of External Lift, Moment, and Pressure Drag of Slender Open-Nose Bodies of Revolution at Supersonic Speeds. Clinton E. Brown and Hermon M. Parker. *U.S., N.A.C.A., Advance Confidential Report No. L5L29* (*Wartime Report No. L-720*), March, 1946. 33 pp., diagrs. 7 references.

Excellent agreement of the calculated lift and moment with experimental data indicates that this approximate method may be used to obtain the aerodynamic characteristics of slender bodies, such as those required for efficient supersonic flight. The comparisons were made with a typical ram-jet body shape at Mach Numbers 1.45, 1.60, 1.75, and 3.0. The pressure-drag calculations were not compared with experimental results because of the uncertainty of the values measured in the tests. The lift

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coefficient was found definitely to increase with increasing Mach Number, while the moment coefficient, taken about the midpoint of the body, decreased.

INTERNAL FLOW

Analysis of the Performance of a Jet Engine From Characteristics of the Components. I—Aerodynamic and Matching Characteristics of the Turbine Component Determined with Cold Air. Arthur W. Goldstein. *U.S., N.A.C.A., Technical Note No. 1459*, October, 1947. 58 pp., illus. 4 references.

Reports influence of aerodynamic characteristics of first nozzle ring on turbine performance. Methods of jet-engine analysis are developed and applied to investigation of interaction of turbine with N.A.C.A. research compressor in such an engine. Stream-filament method of designing high reaction blades was satisfactory. Free-vortex flow was not realized. Reduction in turbine-gas flow capacity was caused by inner shroud boundary layer. The outer boundary layer was unstable. Jet-engine performance may be increased 4.7 per cent by modification of compressor to utilize best turbine efficiency.

A New Method for the Aerodynamic Design of Multistage Axial-Flow Compressors. Hunt Davis. *Journal of the Aeronautical Sciences*, Vol. 15, No. 1, January, 1948, pp. 41–48, diagrs. 2 references. (*See* AER 4/47:29.)

Comparative Performance of Two Vaneless Diffusers Designed with Different Rates of Passage Curvature for Mixed-Flow Impellers. Frank J. Barina. *U.S., N.A.C.A., Technical Note No. 1490*, November, 1947. 11 pp., illus. 2 references.

The diffuser performance is based on a ratio of the overall adiabatic efficiency of the compressor to impeller adiabatic efficiency. The large difference in the passage curvature of the two vaneless diffusers made no appreciable difference in diffuser performance at the peak compressor efficiency for the range of speeds investigated (700 to 1,200 ft. per sec.).

The Development and Application of High-Critical-Speed Nose Inlets. Donald D. Baals, Norman F. Smith, and John B. Wright. *U.S., N.A.C.A., Advance Confidential Report No. L5F30a (Wartime Report No. L-729)*, July, 1945. 133 pp., illus. 14 references.

PERFORMANCE

Generalized Performance Comparison of Large Conventional Tail-Boom, and Tailless Airplanes. Herman O. Ankenbruck and Marion O. McKinney, Jr. *U.S., N.A.C.A., Technical Note No. 1477*, October, 1947. 84 pp., illus. 3 references.

STABILITY & CONTROLLABILITY

Wind-Tunnel Investigation of the Stability and Control Characteristics of a Complete Model Equipped with Vee Tail. Edward C. Polhamus and Robert J. Moss. *U.S., N.A.C.A., Technical Note No. 1478*, November, 1947. 45 pp., illus. 5 references.

A wind-tunnel investigation was conducted to determine the low-speed stability and control characteristics of a complete model equipped with a vee tail. Tail dihedral angles of 35°, 47°, and 55° were tested and the results compared with results of tests of a conventional-tail arrangement used with the same wing-fuselage combination.

Correlation of Wind-Tunnel Predictions With Flight Tests of a Twin-Engine Patrol Airplane. I—Longitudinal-Stability and -Control Characteristics. Noel K. Delany and William M. Kauffman. *U.S., N.A.C.A., Memorandum Report No. A5D04 (Wartime Report No. A-86)*, April, 1945. 61 pp., illus. 5 references.

Flight Measurements of the Flying Qualities of an F6F-3 Airplane (BuAer No. 04776). II—Lateral and Directional Stability and Control. Walter C. Williams and John P. Reeder. *U.S., N.A.C.A., Memorandum Report No. L5B13a (Wartime Report No. L-716)*, February, 1945. 58 pp., figs. 4 references.

Flying Qualities of a High-Speed Bomber with a Dual Pusher Propeller Aft of the Empennage as Estimated from Wind-Tunnel Tests of a 1/8-Scale Powered Model. James A. Weiburg and Alfred W. Schnurbusch. *U.S., N.A.C.A., Memorandum Report No. A4K04 (Wartime Report No. A-78)*, November, 1944. 31 pp., diagrs. 3 references.

Longitudinal Characteristics and Aileron Effectiveness of a Midwing Airplane From High-Speed Wind-Tunnel Tests. Charles F. Hall and Robert L. Mannes. *U.S., N.A.C.A., Memorandum Report (Wartime Report No. A-84)*, September, 1944. 69 pp., illus. 9 references.

Power-On Wind-Tunnel Tests of the 1/8-Scale Model of the Brewster F2A Airplane with Full-Span Slotted Flaps. John G. Lowry. *U.S., N.A.C.A., Memorandum Report (Wartime Report No. L-707)*, August, 1941. 33 pp., figs. 1 reference.

WINGS, AIRFOILS, & EMPENNAGE

Theoretical Additional Span Loading Characteristics of Wings with Arbitrary Sweep, Aspect Ratio, and Taper Ratio. John DeYoung. *U.S., N.A.C.A., Technical Note No. 1491*, December, 1947. 37 pp., diagrs. 9 references.

The Weissinger method has been used to find the lift-curve slope, spanwise center of pressure, aerodynamic center location, and span loading coefficients of untwisted and uncambered wings having a wide range of plan forms. The results are presented in graphical form to facilitate interpolation. Methods are also included for determining induced drag and the approximate effects of compressibility.

Effect of Aspect Ratio and Taper on the Pressure Drag at Supersonic Speeds of Unswept Wings at Zero Lift. Jack N. Nielson. *U.S., N.A.C.A., Technical Note No. 1487*, November, 1947. 32 pp., figs. 4 references.

The source-sink method of R. T. Jones is used to determine the wave drag coefficients at zero angle of attack of the family of unswept wings with diamond airfoil section. Charts presented permit a rapid determination of the drag coefficient at any supersonic Mach Number, aspect ratio, and taper.

Theoretical Lift Distribution and Upwash Velocities for Thin Wings at Supersonic Speeds. John C. Evvard and L. Richard Turner. *U.S., N.A.C.A., Technical Note No. 1484*, November, 1947. 48 pp., figs. 6 references.

Explicit expressions for the upwash over wing tips of fairly general plan form and profile are obtained. The formulation is extended to give a method for obtaining the velocity potential at a point on arbitrary thin wings influenced by isolated or interacting flow fields off the wing plan form.

A Comparison of Three Theoretical Methods of Calculating Span Load Distribution on Swept Wings. Nicholas H. Van Dorn and John DeYoung. *U.S., N.A.C.A., Technical Note No. 1476*, November, 1947. 75 pp., figs.

The Falkner, Mutterperl, and Weissinger methods for estimating span loading are studied to establish their relative accuracy and ease of application. The experimentally determined loading and force characteristics of five wings having sweep angles of from 45° forward to 45° back are used as a basis for judging the accuracy. The Weissinger method gives good accuracy and involves by far the least computing effort, and the Falkner method gives the best accuracy but at considerable expense in computing effort.

Systematic Investigations of the Influence of the Shape of the Profile Upon the Position of the Transition Point. K. Bussmann and A. Ulrich. (*ZWB, Technische Berichte*, Vol. 10, No. 9, und *Vorabdrucke aus Jahrbuch der Deutschen Luftfahrtforschung*, 1943, IA 010, pp. 1–19.) *U.S., N.A.C.A., Technical Memorandum No. 1185*, October, 1947. 51 pp., illus. 10 references.

The position of the beginning of transition from laminar to turbulent flow as a function of the thickness and the camber of the profile at various Reynolds Numbers and lift coefficients was investigated for a series of Joukowsky profiles. The calculation of the boundary layer was carried out according to the Pohlhausen method which may be continued by a simplified stability calculation according to H. Schlichting. Tables permit reading of the position of the transition point on suction and pressure side for each Joukowsky profile.

Flight Measurements of Aerodynamic Loads on the Horizontal Tail Surface of a Fighter-Type Airplane. John B. Garvin. *U.S., N.A.C.A., Technical Note No. 1483*, November, 1947. 55 pp., diagrs. 1 reference.

Wind-Tunnel Investigation of a Section of the Horizontal Tail Surface for the Bell XP-63 Airplane. Milton B. Ames, Jr., and H. Page Hoggard, Jr. *U.S., N.A.C.A., Memorandum Report (Wartime Report No. L-573)*, August, 1941. 28 pp., figs. 2 references.

Two-Dimensional Wind-Tunnel Investigation of Six Airfoil Sections for the Wing of the Vega XP2V-1 Airplane. Felicien F. Fullmer, Jr. *U.S., N.A.C.A., Memorandum Report No. L5I21 (Wartime Report No. L-681)*, October, 1945. 33 pp., diagrs. 1 reference.

The new improved 1948 model Navion built by The Ryan Aeronautical Company.

Air Power

Military Aircraft in Time of Peace. Orvil A. Anderson and Jermain F. Rodenhauser. *Air Affairs*, Vol. 2, No. 1, Autumn, 1947, pp. 17–25.

Airplane Design & Description

Effect of C.A.R. Performance Requirements on Airplane Design. John E. Steiner. *SAE Quarterly Transactions*, Vol. 1, No. 4, October, 1947, pp. 650–661, diagrs. (Cf. AER 5/47:35.)

Ultra-Light Aircraft. II. Peter F. Murray. *The Aeroplane*, Vol. 73, No. 1899, October 31, 1947, pp. 588–590, illus.

Jet Ejects Man at 500 Mph.; English Test (of Martin-Baker Seat) Shows It Can Be Done. *Naval Aviation News*, No. 276, November, 1947, p. 17, illus.

High Spots in High Flight; Speakers at Boeing's Three-Day Symposium Discuss Flight at Altitudes. *Aero Digest*, Vol. 55, No. 5, November, 1947, pp. 52–54.

Cross Wind Landing Gear. Al Goldsmith. *Airports*, Vol. 12, No. 5, November, 1947, pp. 24, 25, diagrs.

A summary of the importance of cross-wind landing-gear design and a brief description of the models being developed under C.A.A. contracts by the Goodyear Aircraft Corporation, the Firestone Aircraft Company, the Bellanca Aircraft Corporation, and All American Aviation, Inc.

For Safer Landing; New Anti-Blowout Inner Tube by Goodyear. *Flight*, Vol. 52, No. 2028, November 6, 1947, p. 512, illus.

A dual-wall tube contains two pressure compartments. When the tire is punctured, the pressure in the outer section is released and the inner wall expands to the normal diameter of the tube. During inflation, a special valve permits both sections to be filled simultaneously. After inflation, the duct between the sections is sealed to make the compartments independent.

Shock Strut Packing. *Plane Facts*, Vol. 6, No. 4, October, 1947, pp. 8, 9, 28. For nose wheel and main landing gear of C-54 and DC-4 airplanes.

Sport- und Touristflugzeug "Aviastarlet FL3" (Sport and Touring Airplane "Aviastarlet FL3"; Azionaria Vercellese Industrie Aeronautiche, Italy). *Schweizer Aero-Revue*, Vol. 22, No. 6, June, 1947, pp. 234, 243, illus.

Sport- und Touristikflugzeuge Cessna 120 und 140. (The Cessna 120 and 140 Sport and Touring Airplanes.) *Schweizer Aero-Revue*, Vol. 22, No. 4, April, 1947, pp. 149–152, 145, diagrs.

De Havilland "Beaver" (DHC.2 Bush Freighter). *Shell Aviation News* (London), No. 112, October, 1947, pp. 23, 24, illus.

"Functional" Trainer; New Fairchild (XNQ-1) with Standardized U.S. Navy Cockpit Layout. Roy Cross. *Flight*, Vol. 52, No. 2028, November 6, 1947, pp. 513, 514, illus.

New Shapes in the Air. XXII—The Fiat G.46 and the Fiat G.55B (Trainers). *The Aeroplane Spotter*, Vol. 8, No. 199, November 1, 1947, p. 245, illus.

Reiseflugzeug Fokker-Van Diepen F.25 "Promotor" (The Fokker-Van Diepen F.25 "Promotor" Touring Airplane). *Schweizer Aero-Revue*, Vol. 22, No. 11, November, 1947, pp. 290, 291.

The Goodyear GA-2 Amphibian. *Air Force*, Vol. 30, No. 11, November, 1947, pp. 32, 33, 47, illus.

Hastings—Its Secrets Revealed (Handley Page R.A.F. Transport). *Handley Page Bulletin*, Vol. 13, No. 152, October, 1947, pp. 3–6, illus.

Prototype Fighters: The Martin-Baker M.B. V and the Miles M.20. *The Aeroplane*, Vol. 73, No. 1899, October 31, 1947, p. 582, illus.

Commercial Types. XXXII—The Miles Aerovan IV. *The Aeroplane Spotter*, Vol. 8, No. 199, p. 249, illus.

French Trainers: Morane-Saulnier M.S. 472 and Morane-Saulnier M.S. 561. *The Aeroplane*, Vol. 73, No. 1900, November 7, 1947, p. 610, illus.

Safir in the Air; An Analysis of the Equipment and Flying Qualities of a New Swedish Three-Seater: S.A.A.B. 91 with Gipsy Major 10 Engine. Maurice A. Smith. *Flight*, Vol. 52, No. 2026, October 23, 1947, pp. 459–462, illus.

Saab Safir, the Gem of the Air. *Svenska Aeroplan Aktiebolaget, Linkoping, Sweden*, 1947. 8 pp., illus. Descriptive brochure.

British Aircraft on Parade. *Shell Aviation News* (London), No. 112, October, 1947, pp. 10–14, illus.

Descriptions of ten of the aircraft exhibited at the eighth flying display and exhibition of the Society of British Aircraft Constructors at Radlett on September 9–12, 1947.

A View of France. III. H. F. King. *Flight*, Vol. 52, No. 2026, October 23, 1947, pp. 471–475, illus. (Cf. AER 1/48:39.)

A Pacific Showcase. A. Marthason. *The Aeroplane*, Vol. 73, No. 1900, November 7, 1947, pp. 614–617, illus. Description of the Douglas DC-6 transport, the XB-42 bomber, the DC-8, the Douglas Cloudmaster, and the Bell Kingcobra.

Airports & Airways

The Application of Existing Techniques to the Development of an Improved System of Air Traffic Control. Warren D. White. *Airborne Instruments Laboratory, Inc., Mineola, N. Y., Report No. 524-1,* June, 1947. 67 pp., diagrs.

In order to improve the reliability and regularity of air transport service at congested centers it is essential that the pilot and the control station be continuously aware of the position of the aircraft. Traffic approaching a terminal must be spaced in sequence while en route and on the runway. Considerations of the technical aspects of systems that might be devised to implement this objective led to the selection of omni-directional range and distance-measuring instruments as the basic equipment. A tentative system was proposed which included an airborne pictorial position indicator, a block signal system, and automatic transmission to the aircraft of the difference between its reported progress and its schedule as a means of providing rate control.

Leasing Airport Facilities. I—Factors in Airport User Charges. II—How to Determine Airport Landing Area Charges. Lynn L. Bollinger. *Public Management,* Vol. 29, Nos. 8, 9, August, September, 1947, pp. 230–234; 258–260.

Tentative conclusions that were derived from a 12-months' intensive investigation of 180 fixed-base businesses and smaller airports in 40 states, conducted by the Aviation Research Staff at the Graduate School of Business Administration, Harvard University.

Airport Terminal Design. Walther Prokosch. *Preprint, S.A.E., National Air Transport Engineering Meeting,* Kansas City, December 1–3, 1947. 8 pp., diagrs.

The basic factor determining the design of an air terminal is the number of plane parking positions. The number can be calculated from the estimated types of traffic and the amount, on a daily basis, of each type that will be accommodated. The parking positions should be arranged according to their use in numbers proportionate to the amount of traffic which they will bear. By arranging properly the originating, through, and terminating positions the flow of passenger traffic can be expedited and maximum use can be made of the merchandizing possibilities of terminal concessions.

Sources of Airport Revenue. A. E. Thomas. *Western Flying,* Vol. 27, No. 11, November, 1947, pp. 16, 17, illus.

Floating Dock for Seaplanes Utilizes Worn Out Tires and Jets of Water. *The Martin Star,* Vol. 6, No. 10, November, 1947, pp. 10, 11, illus.

New Airport Standards Set to Speed Development Work; Civil Aeronautics Administration Specifies Runway Length and Loading on Federal-Aid Projects—Divides Airfields into Six Classifications According to Service. *Engineering News-Record,* Vol. 139, No. 21, November 20, 1947, p. 1 (697).

Advice for Airport Locations. M. W. Cochran. *Airports,* Vol. 12, No. 5, November, 1947, p. 29, illus.

New CAA Airport Markers. *Aero Digest,* Vol. 55, No. 5, November, 1947, p. 68, diagrs.

The Brabazon I and Its Hangar; Britain's Largest Aircraft Building Will Hold Fleet of Giant Air Liners. *Airports & Air Transportation,* Vol. 2, No. 53, October, 1947, pp. 126–128, illus.

Growth of Essendon (Melbourne) International Airport. *Airports & Air Transportation,* Vol. 2, No. 53, October, 1947, pp. 130, 131, illus.

Développement de l'Aéroport de Cointrin (Development of the Airport at Cointrin, Switzerland). *Schweizer Aero-Revue,* Vol. 22, No. 8, August, 1947, p. 335, illus.

All-Weather Flying

Luftverkehr bei Schee und Nebel (Air Transport in Snow and Cloud). H. W. Thommen. *Schweizer Aero-Revue,* Vol. 22, No. 3, March, 1947, pp. 96–98, 104, 105, illus.

Aviation Medicine

The Place of the Aviation Physiologist in the Aeronautical Sciences. M. C. Shelesnyak. *Aeronautical Engineering Review,* Vol. 7, No. 1, January, 1948, pp. 18, 19. 3 references.

The advance of aviation has projected man so far beyond his natural environment that it has become increasingly necessary to employ devices that will compensate for environmental conditions. These devices have become an integral part of aircraft equipment, and their multiplicity and complexity have reached the point where they are a vital factor in the efficiency not only of the aircraft but also of the pilot. Thus, aircraft design and research requires not only the service of an engineer but also of a physiologist. This need was recognized by the military during the past war and hundreds of men were engaged in research, experimentation, and teaching in the field of aviation physiology. The dispersal of this group upon demobilization is a serious loss to aviation. The talents of these men could be conserved if they were to be organized into an association under the auspices of some recognized association and if the aviation industry were to use this roster from which to draw consultants for their research organizations. The importance of this field of study should call for its inclusion in every aeronautical engineering curriculum.

Concerning the Effect of Vibration on the Vegetative Nervous System and the Tendon Reflexes. W. E. Loeckle. (*Jahrbuch der Deutschen Luftfahrtforschung,* AM/Loe/Rp, pp. III 103–III 108.) *U.S., Army Air Forces, Library (Washington), Translation No. 425,* January 17, 1946. 24 pp. 28 references.

Report on the effect of vibration in the inhibiting and the removal of tendon reflexes. The mechanical vibration of a vibration plate and that of a vibrator affected the entire organism or individual points on its surface. The absence of the patellar reflex is caused by the effect of the vibrations on the vegetative nervous system. The vibration of blood vessels and other organs with smooth musculature caused a regional change in the normal tonus of the sympatheticus which manifested itself in the tendon reflex center.

Altitude Adaptation to 8,000 Meters, Acquired at 2,000 Meters Above Sea Level. Th. Benzinger and H. Doring. (*Luftfahrtmedizin,* Vol. 7, No. 2–3, November 25, 1942.) *U.S., Army Air Forces, Library (Washington), Translation No. 399,* December 20, 1945. 15 pp. 8 references.

A high-altitude skiing course conducted in March of 1940 showed that the physiological altitude adaptation obtained at altitudes of 2,000 meters produced an increase in tolerance of high altitudes up to 8,000 meters, particularly increasing the time reserve.

The Hearing Function. Benedetto Casella. [*Trattato di Medicina Aeronautica,* Rome, 1942(?), Chapter 6, pp. 375–420.] *U.S., Army Air Forces, Library (Washington), Translation No. 411,* December 26, 1945. 72 pp. 69 references.

A thorough treatment is given of the physiology of hearing, the behavior of the ear with respect to sound, the measurement of airplane noise and vibration, clinical data on occupational diseases of aeronautical personnel, various methods of disease prevention, and the use of sound to orient aircraft in flight.

Physiopathologie de l'Oeil du Pilote Pendant le Vol (Physiopathology of the Eye of the Pilot During Flight). Giorgio Curiel. *Schweizer Aero-Revue,* Vol. 22, No. 4, April, 1947, pp. 154, 155.

A brief discussion of the effects of high speeds, high altitudes, and rapid acceleration on the eye and on the acuity and reliability of visual preception. A list of precautions is given which should be observed by the pilot to minimize these effects.

Krankhafte Erscheinungen am Auge des Piloten Während des Fluges (Physiopathology of the Eye of the Pilot During Flight). Giorgio Curiel. *Schweizer Aero-Revue,* Vol. 22, No. 6, June, 1947, pp. 248, 249.

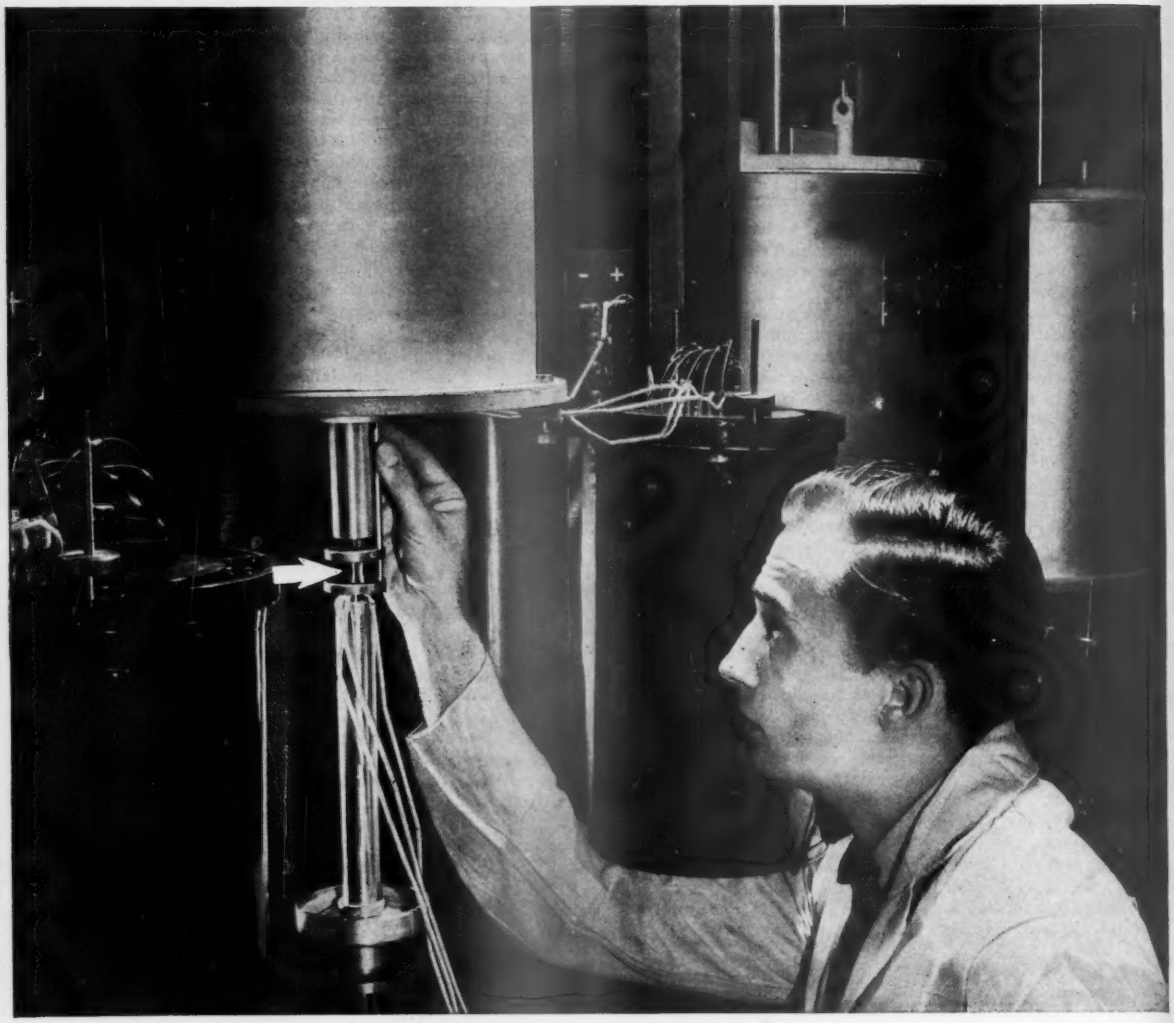
A Paramagnetic Oxygen Analyzer. Clarence A. Dyer. *Review of Scientific Instruments,* Vol. 18, No. 10, October, 1947, pp. 696–702, illus.

The paramagnetic property of oxygen is used to produce a differential cooling of the arms of a hot-wire bridge. The instrument analyzes each inspiration and shows O_2 percentages between 21 and 100.

An Instantaneous Recording Cardiotachometer. Ralph E. Sturm and Earl H. Wood. *Review of Scientific Instruments,* Vol. 18, No. 10, October, 1947, pp. 771–776, diagrs. 5 references.

The electric circuits and operational mechanics of an instantaneous cardiotachometer useful for studying the effects of high positive accelerations. The deflection of the graphic record that is produced is proportional to the time interval between successive *r* waves of the electrocardiogram and is inversely proportional to the heart rate.

Aviation Medicine. B. Groesbeck. *Air Affairs,* Vol. 2, No. 1, Autumn, 1947, pp. 68–78.



THE ALLOY THAT CREEPS BEFORE IT FLIES

▶ This metal alloy specimen is providing information for designers of aircraft engines. It is undergoing a high temperature "creep" test in the Wright Aeronautical Corporation metallurgical laboratory. For months at a time it will be stretched under a tension of thousands of pounds per square inch — at temperatures that will keep it white hot. The test machine can measure as little as 5/100,000 of an inch stretch and control the heat within a tolerance of one degree Fahrenheit.

▶ The "creep" test is conducted on hundreds of specimens to determine how much each will stretch when subjected to extreme loads and temperatures for thousands of hours. It preproduces conditions that the material will encounter in actual operation.

▶ Another example of the resourcefulness with which Wright Engineers pioneer developments in aircraft turbine and reciprocating engines.

POWER FOR AIR PROGRESS

WRIGHT

Aeronautical Corporation • Wood-Ridge, New Jersey

A DIVISION OF CURTISS WRIGHT FIRST IN FLIGHT

Dental Service of the U.S. Air Forces. George R. Kennebeck. *Military Surgeon*, Vol. 101, No. 5, November, 1947, pp. 385–392.

B.O.A.C. Medical Services. *Shell Aviation News* (London), No. 112, October, 1947, pp. 7–9, illus.

Comfortization

Standards of Human Comfort. M. Hottinger. (*Schweizerische Bauzeitung*, Vol. 65, Nos. 8, 9, February 22, March 1, 1947, pp. 98–102, 107–112.) *Engineers' Digest*, Vol. 4, No. 10, October, 1947, pp. 461–466, diagrs. A review.

Education & Training

Development of Plastic Training Aids. D. B. Stevens. *Plane Facts*, Vol. 6, No. 4, October, 1947, pp. 10, 11, 26, illus.

The P-80 Captivair. M. S. Blackman. *Plane Facts*, Vol. 6, No. 4, October, 1947, pp. 16, 17, illus.

A P-80 airplane is mounted on concrete piers in an attitude of normal flight as a preflight training device. All controls can be operated in the same manner as in flight. An instructor in a remote housing can control the indication of the aircraft instruments to provide the student in the cockpit with simulated indication of normal and abnormal flight.

Electronics

Radio Doppler Effect for Aircraft Speed Measurements. Leonard R. Malling. *Institute of Radio Engineers, Proceedings*, Vol. 35, No. 11, November, 1947, *Waves and Electrons Section*, pp. 1357–1360, illus. 1 reference.

Description of the operation of and the circuits used in the Boeing doppler ground-speed meter. The doppler effect is obtained with a continuous-wave ground station and an airborne relay transmitter which doubles the received frequency. The use of the doppler effect permits almost instantaneous measurement of the ground speed of an aircraft. The pilot is free to fly any course radial to the ground station and danger of high-speed flight at low altitudes is eliminated.

Detectability and Discriminability of Targets on a Remote Projection Plan-Position Indicator. W. R. Garner and Ferdinand Hamburger, Jr. *Institute of Radio Engineers, Proceedings*, Vol. 35, No. 11, November, 1947, pp. 1220–1225, diagrs. 1 reference.

Quantitative results were obtained on minimum detectable signals and minimum separation between two targets as a function of the following variable factors: Video gain, C.R.T. bias, signal clipping, light-source intensity, type of diffraction screen, and position of the operator. The projection (PPI), using a dark-trace tube, appeared to be one db. worse than a standard 5-in. PPI, when each instrument was operated under its optimal conditions.

Flight Measurements by Television. *Aero Digest*, Vol. 55, No. 5, November, 1947, p. 55, illus.

Television-telemetering developed by the Farnsworth Television & Radio Corporation enables observers at a ground station to see all instrument recordings and indicators of pressures, strains, and structural failures of a test airplane in the air. Not only is the pilot left free to concentrate on his flight instruments but a permanent photographic record is obtained of the entire flight. The ground observers are in a position to warn the pilot by radio of impending structural failure.

The Classification of Radio Position-Finding Systems. C. E. Strong. *Engineering*, Vol. 164, No. 4265, October 24, 1947, p. 398. (Extended abstract of a paper.)

First with the "Seeing Eye"; "The Poor Man's Radar," APS-10, Does a Two-Fold Job for Peruvian International Airways. Nathaniel F. Silsbee. *Aero Digest*, Vol. 55, No. 5, November, 1947, pp. 23, 24, illus.

Considerations in the Design of a Radar Intermediate-Frequency Amplifier. Andrew L. Hopper and Stewart E. Miller. *Institute of Radio Engineers, Proceedings*, Vol. 35, No. 11, November, 1947, pp. 1208–1219, illus. 6 references. For ±100-db. amplification in a bandwidth of 1–10 mc., centered at frequencies in the 30- and 60-mc. region.

A Method of Virtual Displacements for Electrical Systems with Applications to Pulse Transformers. Prescott D. Crout. *Institute of Radio Engineers, Proceedings*, Vol. 35, No. 11, November, 1947, pp. 1236–1247, diagrs. 5 references.

A method of virtual displacements is developed for obtaining the transient behavior of electrical systems with distributed constants. This method involves the association of a number of assumed "current modes" with generalized coordinates and gives a set of equations that duplicates the mesh equations of a corresponding equivalent lumped network. The procedure developed is applicable to many different types of problems, such as those involving thermal systems. Here, however, it is applied to the pulse transformer, the result being equivalent networks and procedures for calculating the constants in these networks.

Distortion in Pulse-Duration Modulation. Ernest R. Kretzmer. *Institute of Radio Engineers, Proceedings*, Vol. 35, No. 11, November, 1947, pp. 1230–1235, diagrs. 12 references.

Pulse-duration modulation inherently gives rise to some audio distortion. The distortion is put in relation to system parameters by a method of analysis that is exact, and therefore correct for any degree of modulation, but is not suitable for periodic sampling. Results are applied to three cases in which the ratio of average pulse duration to pulse-repetition period varies.

A Wide-Band 550-Megacycle Amplifier. Raymond O. Petrich. *Institute of Radio Engineers, Proceedings*, Vol. 35, No. 11, November, 1947, *Waves and Electrons Section*, pp. 1371–1374, diagrs. 4 references.

A five-stage 550-mc. amplifier having an all-over bandwidth of 20 mc. and a gain of 10 db. per stage. It uses a 2C43 triode in a grounded-grid circuit with an impedance-transforming band-pass filter in the output to give the desired bandwidth. A visual method of alignment with a sweep-frequency oscillator is described.

Propagation of Radio Waves in the Lower Troposphere. J. B. Smyth, L. G. Trolese. *Institute of Radio Engineers, Proceedings*, Vol. 35, No. 11, November, 1947, pp. 1198–1202, diagrs. 19 references.

The effect of tropospheric layers on the propagation of high-frequency radio waves has been experimentally investigated. The theory proposed is in agreement with the salient propagation characteristics observed on a nonoptical link. Fields beyond the optical horizon are governed by the layer height and the refractive index change through the layer. For low layers the higher frequencies have the advantage because of height gain, whereas for higher layers the lower frequencies have the advantage of higher reflection coefficients.

The Determination of Ionospheric Electron Distribution. Laurence A. Manning. *Institute of Radio Engineers, Proceedings*, Vol. No. 11, November, 1947, pp. 1203–1207, figs. 8 references.

The virtual height versus frequency interval is derived, neglecting absorption and the earth's magnetic field. It is shown how solution of this integral equation can be obtained using the Laplace transformation, and how true height versus frequency can be determined graphically from virtual height versus frequency curves. Application of the method is made to some typical nighttime and daytime ionosphere records.

The Oblique Reflexion of Very Long Wireless Waves From the Ionosphere. M. V. Wilkes. *Royal Society of London, Proceedings, Series A*, Vol. 189, No. 1016, March 27, 1947, pp. 130–147, figs. 17 references.

An attempt is made to provide a satisfactory theoretical basis for a future discussion of the experimental data on the propagation of very long radio waves (18,800 m.) given by Best, Ratcliffe, and Wilkes, and Budden, Ratcliffe, and Wilkes. The reflection of very long plane waves incident obliquely on a horizontally stratified ionized medium with a vertical magnetic field is first considered in general terms, and it is shown that the medium can be divided into a transition region and a reflecting region.

On the Propagation of Electromagnetic Waves Through the Atmosphere. B. K. Banerjea. *Royal Society of London, Proceedings, Series A*, Vol. 190, No. 1020, June 17, 1947, pp. 67–81, figs. 32 references.

Dimensional Analysis of Electromagnetic Equations. A. M. Winzemer. *Institute of Radio Engineers, Proceedings*, Vol. 35, No. 11, November, 1947, *Waves and Electrons*, pp. 1383, 1384, table.

Broad-Band Noncontacting Short Circuits for Coaxial Lines. III—Control of Parasitic Resonances in the S-Type Plunger. W. H. Huggins. *Institute of Radio Engineers, Proceedings*, Vol. 35, No. 11, November, 1947, pp. 1324–1328, diagrs. 4 references. (Cf. AER 1/48:43.)

Microwave Converters. C. F. Edwards. *Institute of Radio Engineers, Proceedings*, Vol. 35, No. 11, November, 1947, pp. 1181–1191, diagrs. 4 references. Discussion of the use of point-contact silicon rectifiers as the nonlinear element, with emphasis on rectifier input and output networks.

The Equivalent Circuit of a Corner Bend in a Rectangular Wave Guide. John W. Miles. *Institute of Radio Engineers, Proceedings*, Vol. 35, No. 11, November, 1947, pp. 1313–1317, diagrs. 2 references.

The High-Speed Radar Switch. *Radio News*, Vol. 9, No. 5, November, 1947, *Radio-Electronic Engineering*, pp. 6, 7, 24, illus. Description and operation of the Westinghouse 1B24 transmit-receive switch for 10,000 mc.

Microwave Filters Using Quarter-Wave Couplings. R. M. Fano and A. W. Lawson, Jr. *Institute of Radio Engineers, Proceedings*, Vol. 35, No. 11, November, 1947, pp. 1318–1323, diagrs. 11 references.

A Highly Directional Microwave Antenna. Tom Gootee. *Radio News*, Vol. 9, No. 5, November, 1947, *Radio-Electronic Engineering*, pp. 3–5, 20, illus. 6 references.

The antenna designed by W. M. Sharpless of Bell Laboratories provides at 1.25 cm. a beam width of 0.12° at half-power points, with either horizontal or vertical polarization. Mathematical analysis of the design.

Video Storage by Secondary Emission from Simple Mosaics. Robert A. McConnell. *Institute of Radio Engineers, Proceedings*, Vol. 35, No. 11, November, 1947, pp. 1258–1264, diagrs. 15 references.

Recent Advances in Luminescent Materials for Electronic Devices. H. Meyer and G. A. R. Tomes. *Electronics Forum* (London), No. 5, March, 1947, pp. 27–42, diagr.

The Theory of the Magneto-Resistance Effects in Metals. E. H. Sondheimer and A. H. Wilson. *Royal Society of London, Proceedings, Series A*, Vol. 190, No. 1023, September 9, 1947, pp. 435–454. 6 references.

The Surface Impedance of Superconductors and Normal Metals at High Frequencies. I—Resistance of Superconducting Tin and Mercury at 1200 Mcyc./Sec. II—The Anomalous Skin Effect in Normal Metals. III—The Relation Between Impedance and Superconducting Penetration Depth. A. B. Pippard. *Royal Society of London, Proceedings, Series A*, Vol. 191, No. 1026, November 18, 1947, pp. 370–415, figs. 18 references.

Equipment

Flight Tests of Several Exhaust-Gas-to-Air Heat Exchangers. Richard Jackson and Wesley H. Hillendahl. *U.S., N.A.C.A., Advance Restricted Report No. 4C14 (Wartime Report No. A-46)*, March, 1944. 56 pp., illus. 18 references.

ELECTRICAL

Electrical Snap-Action Temperature Controls for Aircraft. J. R. Campbell. *American Society of Mechanical Engineers, Transactions*, Vol. 69, No. 8, November, 1947, pp. 821–825, Discussion, pp. 825–827, illus. 3 references.

A detailed description of the design and characteristics of the Cam-Stat thermostat. Bimetallic spring blades sensitive to temperature differentials down to 2°F. throw a single-pole double-throw switch. The action is of the snap type and 1/8 hp. on d.c. and 1/4 hp. on a.c. can be accommodated. The instrument can be adjusted between −100°F. and 600°F.

Characteristics of Silver and Copper for Use as Electrical Contacts. B. W. Jones and L. I. Zickrick. *Product Engineering*, Vol. 18, No. 11, November, 1947, pp. 104–107, illus.

A comparison of significant electrical and metallurgical properties. Both silver- and copper-sulfide films exhibit a decrease in resistance as the current is increased. But unlike copper sulfide, the reduction in resistance of silver sulfide is stable. Silver oxide, when it forms on electrical contacts, is reduced to pure silver by the heat generated in the tips from the passage of the current. Copper oxide film is increased with temperature. This cumulative effect can be sufficient to insulate the contact tips. The welding and arcing characteristics of these metals and their susceptibility to solder contamination are examined.

Investigation of Foreign Electrical Batteries (Project No. DQ 126). F. X. Brennan. *U.S., Air Force, Summary Report No. FSU-1155-ND*, October, 1947. 33 pp., illus.

A summary of German development during World War II. One primary battery for use in missiles consisted of alternate layers of zinc, paper, lead with a lead dioxide coating, and paper, and used zinc in the cathode. Circular holes in the laminations permitted the flow of the electrolyte, a solution of sulphuric acid and lead sulfate. In the manufacture of secondary lead-acid batteries, plate grids of iron, wood, or plastic were impregnated with lead as an economy measure. When chemically inactive materials were used, the plates were not strong enough. The efficiency of the battery was too low when chemically active materials were used for the grid. An extensive detailed description is given of a secondary alkaline battery using nickel and cadmium as the electrocouple. Design, production methods, assembly, and applications are described. Production models of the battery displayed erratic behavior under service conditions, which was attributed either to poor manufacturing or control processes.

HYDRAULIC & PNEUMATIC

Damping Characteristics of Dashpots. John B. Peterson. *Product Engineering*, Vol. 18, No. 11, November, 1947, pp. 138–140, diagrs.

A technical study of a dashpot designed at the National Bureau of Standards, which was made for a liquid cushioning medium, the flow of which was assumed to be laminar. Damping coefficients are derived from the common differential equation for damped vibrations of a system. Formulas are developed for the rate of travel of a circular piston moving concentric to a circular cylinder, a circular piston travelling eccentrically in a circular cylinder, and for a circular piston moving in an elliptical cylinder. The experimental velocities determined for a piston moving eccentrically verified the mathematical analysis at low piston velocities. At high velocities, when turbulent flow existed, the velocities were much lower than those calculated.

Remote Hydraulic Control. Harry P. Kupiec. *Product Engineering*, Vol. 18, No. 11, November, 1947, pp. 136, 137, illus.

A description of an all-hydraulic control system that can govern the flow of hydraulic fluid in lines of any capacity at pressures up to 3,000 lbs. per sq.in. and which is lighter and less expensive than other systems. The fluid and pressure in the control line is integral with the medium in the master power lines. A pilot valve upsets the hydraulic pressure in the control line; the resulting pressure differential acts through specially designed poppet valves and permits the circulation of the hydraulic fluid through the power cylinder.

O-Ring Seals in the Design of Hydraulic Mechanisms. David R. Pearl. *SAE Quarterly Transactions*, Vol. 1, No. 4, October, 1947, pp. 602–611, illus. (Cf. AER 8/47:46.)

Aircraft Air Compressors. J. A. Oates. *Aircraft Production*, Vol. 9, No. 109, November, 1947, pp. 425–429, illus.

The methods used in the turning, grinding, and honing of the cylinder, piston, and valves of the Heywood air compressor, manufactured by the Hymatic Engineering Co., Ltd.; also the inspection methods used and the tolerances that are allowed in this two-cycle single-piston compressor.

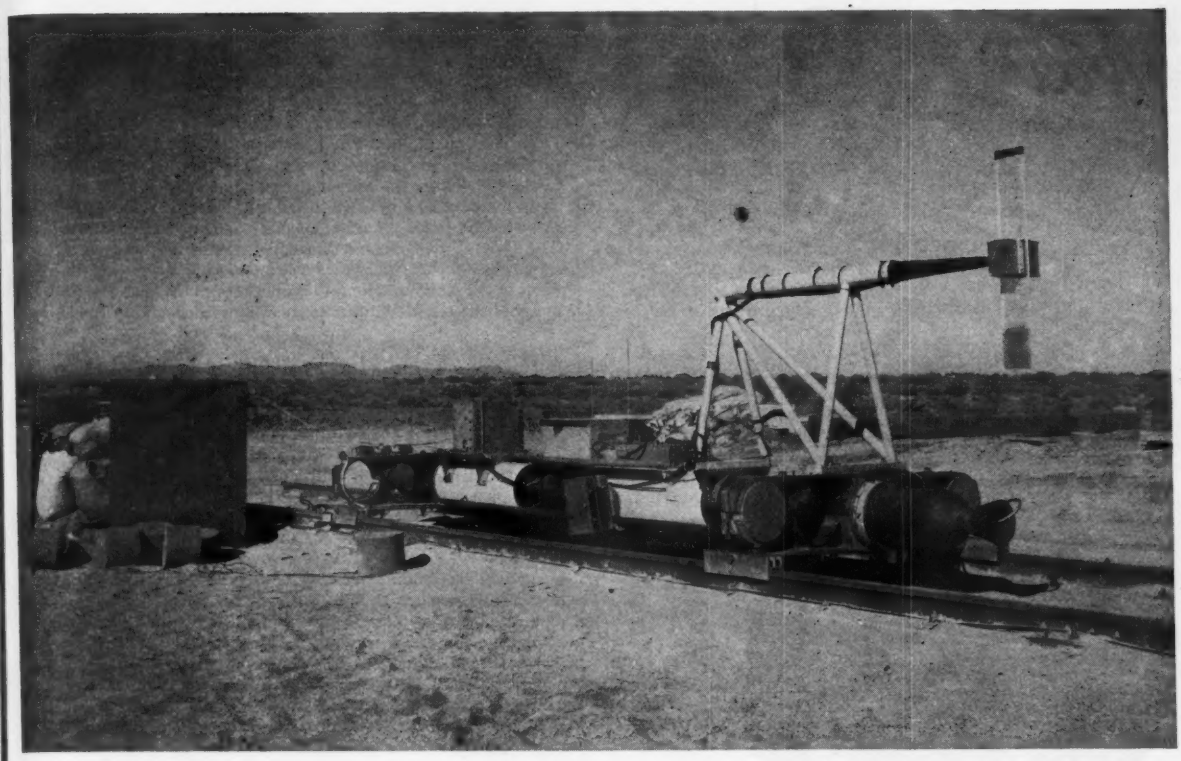
Flight Testing

The Correlation of Wind-Tunnel and Flight-Test Stability and Control Data for an SB2C-1 Airplane. Marion T. Hockman and Robert E. Eisiminger, Jr. *Journal of the Aeronautical Sciences*, Vol. 15, No. 1, January, 1948, pp. 5–17, diagrs. 8 references. (*See* AER 6/47:25.)

Fuels & Lubricants

Kinetic Boundary Friction. J. R. Bristow. *Royal Society of London, Proceedings, Series A*, Vol. 189, No. 1016, March 27, 1947, pp. 88–102, 1 p. plates. 25 references.

It is shown that the exhibition of smooth sliding and relaxation oscillations, or "stick-slips," under conditions of boundary lubrication, when frictional forces are measured by the deflection of an elastic system, may be explained as due to the dependence of kinetic friction on velocity. In the cases giving smooth sliding, kinetic friction decreases as velocity decreases, at very low speed; for the cases giving relaxation oscillations, kinetic friction increases as velocity decreases. That is, sliding under boundary conditions is not inherently discontinuous, any discontinuous motion being due to the dynamics of the measuring instrument, and is the result of kinetic friction increasing as velocity decreases.



Northrop Aircraft's "outdoor wind tunnel," used for wind-model testing on a 2,000-ft. stretch railway near Muroc Air Base. Reversing the system used in indoor wind tunnels, this rocket-powered, rail-mounted sled pushes models through the free air at supersonic speeds of over 1,000 m.p.h.

An Electron-Diffraction Study of the Heating of Straight-Chain Organic Films and Its Application to Lubrication. K. G. Brummage. *Royal Society of London, Proceedings, Series A*, Vol. 191, No. 1025, November 11, 1947, pp. 243–252, figs. 8 references.

Thin films of normal paraffins, fatty acids, and esters have been examined by electron diffraction during heating upon a variety of metal surfaces. In all cases the films lost their orderly condensed structure at comparatively low temperature, leaving expanded films of individual molecules. The disorientation temperatures observed depended upon the chemical composition and thickness of the films, and upon the substrate metal. Evidence has been obtained of the formation of metallic soaps when fatty acid films are deposited upon reactive surfaces such as copper, cadmium, and mild steel. Close agreement has been found between disorientation temperatures and the temperatures of friction discontinuities measured by other workers using Bowden-Leben type of friction apparatus.

Gliders & Gliding

Die Neuen Grundlagen des Segelfluges (The New Bases of Soaring Flight). I. Walter Georgii. *Schweizer Aero-Revue*, Vol. 22, No. 4, April, 1947, pp. 137–139, illus. A survey of the techniques that have been developed in soaring and a detailed explanation of the use of atmospheric waves for long-distance soaring.

Les Fondements Nouveaux du Vol à Voile (The New Bases of Soaring Flight). Walter Georgii. *Schweizer Aero-Revue*, Vol. 22, No. 7, July, 1947, pp. 268, 269.

Segelflug-Aerologie: Alpine Wellen (Sailplane Aerology: Alpine Waves). W. Georgii. *Schweizer Aero-Revue*, Vol. 22, No. 11, November, 1947, pp. 283, 284, diagrs. A description of the atmospheric waves in the Tyrolean Alps which can be used in sailplane operation.

Englischer Segelflug-Doppelsitzer Short- "Nimbus" (English Two-Place Sailplane Short "Nimbus"). *Schweizer Aero-Revue*, Vol. 22, No. 7, July, 1947, p. 269, illus.

Der Schweizer Doppelsitzer T.G. 3A, S.G.S. 2-12 (The Schweizer Two-Seater). *Schweizer Aero-Revue*, Vol. 22, No. 8, August, 1947, pp. 326, 327, illus.

Soaring in France. Guy Borge. *Sailplane and Glider*, Vol. 15, No. 11, November, 1947, pp. 5–8, illus.

Guided Missiles

Loss of Spin of Projectiles. I—Experimental Method. J. A. Van Allen. **II—Skin Friction Drag.** H. P. Hitchcock. *Journal of the Aeronautical Sciences*, Vol. 15, No. 1, January, 1948, pp. 35–40, diagrs. 2 references. (*See* AER 8/47:31.)

Missile Skin Temperature Tests. *Plane Facts*, Vol. 4, No. 3, August, 1947, pp. 9, 10, diagrs.

Thermocouples were installed at 24 points on the skin of a V-2 rocket in order to obtain confirmation of computed skin temperatures. The data obtained by the sensing elements were radio-telemetered from the test missile to the Naval Research Laboratory's 23-channel pulse-time-modulated telemetering system. The temperature distribution and variation for the trajectory followed the general trend of the theoretical analysis.

Trends in Guided Missiles. William L. Clay. *Ordnance*, Vol. 32, No. 165, November-December, 1947, pp. 154–156, illus. A general survey of development trends.

U.S.S. Midway Firing of V-2 Heralds New Weapon. *Naval Aviation News*, No. 276, November, 1947, p. 17, illus.

German Guided and Rocket Missiles. III, IV, V. Eric Burgess. *The Engineer*, Vol. 184, Nos. 4786, 4787, 4788, October 17, 24, 31, 1947, pp. 356–358; 381–383; 407–409, illus. (Cf. AER 1/48:44.)

III. A detailed description of the construction and performance characteristics of the X and Feuerlillie series of guided missiles. The X-4, which is typical of the X series, is an air-air, wire-controlled, rocket-propelled antiaircraft projectile. The Hecht, the first of the Feuerlillie series, resembled a small aircraft with sharply sweptback wings and was intended as a ground-air weapon and flew a preselected course.

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IV. Description of the Taifun, a bifuel rocket fired by a cordite pressure charge, and the Enzian, a ground-air guided missile similar to the Me 163 which was employed as a target-defense interception fighter. The Natter BP 20 produced by Bachem was a missile of the same type but was piloted. On completion of the mission the pilot bailed out and the engine was jettisoned.

V. Design and performance characteristics of the Reintochter produced by Rheinmetal Borsig. This is a ground-air guided missile powered by a two-stage rocket with a ceiling of 20,000 ft. and a range of 24 miles. Both radar and line-of-sight control were provided to direct the missile against enemy bomber formations. The Tromsdorff-Geschoss is a rocket-powered artillery-fired long-range rocket that was never used operationally. The development of the A series of long-range rockets which began in 1933 and includes the missile known as the V-2 is outlined in detail.

Ice Prevention

General Results of N.A.C.A. Flight Research in Natural Icing Conditions During the Winters of 1945 and 1946. Norman R. Bergrun. *Aeronautical Engineering Review*, Vol. 7, No. 1, January, 1948, pp. 20–27, illus. 12 references.

Between January, 1946, and May, 1947, a Curtiss-Wright C-46, equipped with a thermal anti-icing system, was used to continue the research on ice prevention under flight conditions which was begun in 1945. Special meteorological instruments not previously available and heated test sections were installed in order to obtain meteorological data relative to aircraft icing and the amount of heat required for ice protection of various parts of the airplane. The results obtained during 75 flights verified the prediction of large liquid-water contents in the tops of cumulus clouds. The liquid-water concentrations in cumulus clouds can can readily reach twice the value associated with layer-type clouds. The size of cloud droplets has an important bearing on the amount of heat required for ice protection. The observations that were made of the performance of the thermal ice-prevention system installed in the test airplane showed that any similar system having an equivalent dry-air performance would provide satisfactory protection for virtually unlimited flight in icing conditions.

Heat Requirements for Instruments and Airfoils During Ice Storms on Mt. Washington. V. J. Schaefer. *American Society of Mechanical Engineers, Transactions*, Vol. 69, No. 8, November, 1947, pp. 843–846, illus.

A device constructed for measuring the heat required to reach specific anti-icing conditions was used at the Mt. Washington Observatory during 94 regular icing observations in the period January–March, 1946. During these runs the power requirements were determined for keeping a small cylindrical calrod unit, 0.81 cm. in diameter, at four anti-icing conditions: dry surface, trace of water on the leading edge, wet surface, and trace of ice on the leading edge. Observations were made in conjunction with regular multicylinder icing runs so that all heat data are related to liquid-water content, effective particle size, air speed, temperature, snow intensity, and rate of deposition on cylinders. To provide satisfactory anti-icing properties for small instruments and airfoils, a maximum value of 10 watts per sq.cm. is required to cope with extreme conditions. About a third of this value is needed to prevent ice accretion. At least 15 watts per sq.cm. are required for plane installations because of the increased air-speed factor.

Thermal Anti-Icing Survey on Mt. Washington. A. G. Guibert. *American Society of Mechanical Engineers, Transactions*, Vol. 69, No. 8, November, 1947, pp. 829–832, illus. 3 references.

Data on the performance of a few electrically heated cylinders of varying diameter and of an electrically heated airfoil in icing conditions. The rate of catch of the supercooled drops (pounds of water per hour for 1-ft. span) and the heat rate per unit area, together with a comment on the surface conditions, provide some indication of the severity of icing. In general, a heat requirement greater than that given in A.A.F. specifications for thermal anti-icing seems indicated. The partial wettedness of the heated surfaces which was observed on the test equipment at Mt. Washington requires revision of the basic equations presented in A.A.F. Technical Report No. 4972, Addendum I, 1946, by Tribus, Tessman, and others. Computations of the ratio of the mass-transfer area, on the basis of the revised equation similar to one suggested, were made for a number of runs; the results are tabulated. The effects of various surface treatments with respect to surface wet-

tedness and with respect to the heat-transfer data are treated briefly.

A Method for Calculating the Heat Required for Windshield Thermal Ice Prevention Based on Extensive Flight Tests in Natural Icing Conditions. Alun R. Jones, George H. Holdaway, and Charles P. Steinmetz. *U.S., N.A.C.A., Technical Note No. 1434*, November, 1947.

The accuracy of the method was established by a comparison between calculated values of the heat required and measured values obtained from various windshield configurations in actual flights in icing conditions and was found to be adequate for design purposes. In addition to the internally heated windshield, some test data were obtained for a windshield ice-prevention system in which heated air was discharged into the windshield boundary layer. This latter system proved to be thermally inefficient.

Thermal Anti-Icing. *Western Flying*, Vol. 27, No. 11, November, 1947, pp. 14, 15, illus.

A description of the system developed by the Boeing Aircraft Company. Combustion units that burn aviation gasoline supply heated air to the leading edge and tips of the wing and to the leading edges of the tail surfaces. A total of eight burners consume 23 gal. of fuel per hour and can maintain a temperature differential of 100°F.

A Method for Estimating Heat Requirements for Ice Prevention on Gas-Heated Hollow Propeller Blades. V. H. Gray and R. G. Campbell. *U.S., N.A.C.A., Technical Note No. 1494*, December, 1947. 58 pp., diagrs. 19 references. Evaluation of surface temperatures, gas pressures, tip nozzle areas, flow passages, and heat source input.

Water Spray Test Propeller Electrical Deicing Heating Elements. J. A. Kimberly. (Whirl Test No. 1809.) *U.S., Army Air Forces, Technical Report No. 5591*, June 13, 1947. 7 pp., illus.

Propeller Rubber Deicing Element Water Abrasion Test. G. G. Skitek. (Whirl Test No. 2144.) *U.S., Army Air Forces, Technical Report No. 5606*, July 11, 1947. 13 pp., illus.

Instruments

Examination of the Natural Frequency of an Automatically Controlled Aircraft in Relation to the Control Constants and the Inertia of the Automatic Control Mechanism. Würthner. (*Siemens Report No. 77Lg1—U64*, February 22, 1940). *Cornell Aeronautical Laboratory, Translation*, May, 1947. 13 pp., figs.

An investigation of the theoretical effect of yaw and yaw rate sensing constants on the natural frequency of a directionally controlled aircraft having autopilots with and without inertia. The natural frequency increases with an increase in the yaw sensing constant for the inertialess autopilot. Large increases in the yaw rate sensing constant may cause the frequency to drop to zero and the oscillation to become aperiodic. The natural frequency of the airplane increases the frequency of the airplane control oscillation.

For the low frequency cases investigated there is often a minimum natural frequency for a certain yaw sensing constant when using an autopilot with inertia. Ordinarily, however, an increase in yaw sensing constant increases the natural frequency. When the yaw rate sensing constant is increased, on the other hand, the natural frequency increases for an autopilot with inertia. The natural frequency of the airplane again causes an increase of the control frequency.

Design of Instrument Dials for Maximum Legibility. I—Development of Methodology and Some Preliminary Results. *U.S., Air Force, Air Materiel Command, Engineering Division, Aero Medical Laboratory, Memorandum Report No. TSEAA-694-1L*, October 20, 1947. 42 pp., illus. 8 references. Includes: A Methodological Study of Dial Reading. William E. Kappauf, William M. Smith, and Charles W. Bray. Princeton University, Department of Psychology, Report No. 3, August, 1947.

Further Studies of the Effect of Vibration and Other Factors on Legibility of Numerals. Mason N. Crook. *U.S., Air Force, Air Materiel Command, Engineering Division, Aero Medical Laboratory, Memorandum Report No. TSEAA-694-1K*, October 21, 1947. 17 pp. Includes: Effect of Vibration on Legibility of Tabular Numerical Materials, Experiments 5 to 7. Mason N. Crook, Arthur C. Hoffman, and others. Tufts College, Medford, Mass., Aviation Psychology Project, Report No. 4, August, 1947.

Electrical Dynanometer. M. Cox. *Gt. Brit., British Intelligence Objectives Sub-Committee, Final Report No. 117, Item No. 25.* 5 pp., diagr. British Information Services, New York. $0.55.

An apparatus of simple and robust construction for measuring torque without the use of slip-rings. It is especially suitable for very high speeds. By using a null method the error amounts to under 0.5 per cent, and, as a direct reading instrument, the error is less than 1 per cent. In the latter case it is possible to take readings from a distance.

An Ignition Analyzer for Internal-Combustion Engines. H. C. Welch and J. V. McNulty. *SAE Quarterly Transactions*, Vol. 1, No. 4, October, 1947, pp. 662–668, illus. (Cf. AER 3/47:67.)

Introducing George Junior. *The Aeroplane*, Vol. 73, No. 1899, October 31, 1947, pp. 597, 598, illus.

The A.L. 1 automatic control developed by the Sperry Gyroscope Company, Inc., known as the Pilot Aid, is a light-weight low-cost system designed for the control of aircraft weighing under 1,500 lbs. A directional and a vertical gyro control the aileron and the elevators through low-pressure pneumatic servos that incorporate feedback potentiometers. Turns can be made up to a limit of 20° roll and climb and dives are within 10° limits. In operation the system engages smoothly and shows no tendency to hunt. The low-pressure pneumatic actuators allow the pilot, when necessary, to override the control system manually.

Britain's New Automatic Pilot; Smith's "SEPI" Is Claimed to Be Superior to Any Other in the World. *Airports & Air Transportation*, Vol. 2, No. 53, October, 1947, pp. 145, diagrs.

A New British Radio Compass; Standardized for the R.A.F. and Available for Civil Aircraft. *Flight*, Vol. 52, No. 2028, November 6, 1947, pp. 511, 512, illus.

Brief description of an instrument that, with either manual or automatic operation, can give a bearing on any radio transmitter. A mechanical linkage between loop antenna and indicator provides quadrantal error correction.

Engine Trouble Shooting in the Air. John E. Lindberg, Jr. *SAE Quarterly Transactions*, Vol. 1, No. 4, October, 1947, pp. 630–638, illus. (Cf. AER 3/47:67.)

Odometer Advantages for Manufacturers. II. Glenn D. Angle. *Airports*, Vol. 12, No. 5, November, 1947, p. 28. (Cf. AER 1/48:45.)

Navigation Leicht Gemacht—Mit dem Swissair-Navigator (Navigation Made Easy—With the Swissair-Navigator). A. Fischer. *Schweizer Aero-Revue*, Vol. 22, No. 6, June, 1947, pp. 246, 247, 232, illus. Description and use of a circular computer intended for transport and private pilots.

La Navigation Facile Grâce au "Swissair-Navigator" (Easy Navigation, Thanks to the "Swissair-Navigator"). A. Fischer. *Schweizer Aero-Revue*, Vol. 22, No. 11, November, 1947, pp. 286, 287.

Carl Zeiss, Jena; Some Details of Production Processes. E. Wilford Taylor and A. J. Philpot. *Combined Intelligence Objectives Sub-Committee, Item No. 9, File No. 33-64*, April 14, 1947. 19 pp. British Information Services, New York. $0.70.

Laws & Regulations

International Private Law. Arnold W. Knauth. *Air Affairs*, Vol. 2, No. 1, Autumn, 1947, pp. 61–67.

United Nations Trusteeships. John C. Cooper. *Air Affairs*, Vol. 2, No. 1, Autumn, 1947, pp. 115–127.

Maintenance

Cutting Aircraft Engine Maintenance Cost. E. A. Droegemuller. *American Society for Testing Materials, Bulletin*, No. 148, October, 1947, pp. 79–86, illus.

A discussion of unpublished data obtained from Pratt & Whitney fuel tests. Maintenance and operating costs can be lowered by reducing the frequency of engine overhaul. This can be accomplished by proper control of operating power level, lead content, antiknock rating of fuels, and the solid content of both the fuel and the products of combustion.

Boeing Service Guide. (No. 1), October, 1947. 15 pp., illus. Principal features of the Boeing 377 Stratocruiser, dimensions, and basic servicing data. Contents: Boeing Presents the 377 Stratocruiser, and Model 377 Ground Handling, Dimensions and Requirements.

Management & Finance

Airline Insurance Losses Heavy in '47. William E. Blain. *American Aviation*, Vol. 11, No. 14, December 15, 1947, pp. 13–15, table. A review.

Materials

Ultrasonic Resonance Applied to Non-Destructive Testing. Wesley S. Erwin and Gerald M. Rassweiler. *Review of Scientific Instruments*, Vol. 18, No. 10, October, 1947, pp. 750–753, illus. 6 references.

The specimen under test is excited by an oscillator whose frequency varies continuously through a range that encompasses the natural frequency of the specimen. The fundamental and harmonic longitudinal vibrations that are set up induce responses in the piezoelectric quartz-crystal pickup which are displayed on a cathode-ray screen. From these indications the thickness of the specimen can be deduced and flaws can be detected.

Limits of Precision in the Determination of Lattice Parameters and Stresses by the Debye-Scherrer Method. Hans Ekstein and Stanley Siegel. *U.S., N.A.C.A., Technical Note No. 1375*, October, 1947. 22 pp., illus. 8 references.

The spectral width of a characteristic radiation is the limiting factor when the geometric-line width has been reduced sufficiently. The intensity distribution in the line is calculated for the more ideal case. Photographs taken with copper radiation on zinc samples of different crystal-grain sizes show the transition from the jagged to the theoretical, smooth, intensity curve. Errors due to film density irregularities are indicated.

A Connexion Between the Criterion of Yield and the Strain Ratio Relationship in Plastic Solids. Sir Geoffrey Taylor. *Royal Society of London, Proceedings, Series A*, Vol. 191, No. 1027, December 3, 1947, pp. 441–446, figs. 3 references.

The assumption that the work done during a small plastic strain is a maximum as the yield-stress criterion is varied is shown to give rise to a connection between the yield-stress and the strain-ratio relationship. The strain-ratio relationship is that which exists between the ratios of principal stress differences and the ratios of the corresponding strain differences. It is common to assume that this relationship is one of simple proportionality. Experiments, however, show that this assumption is not true in metals. The observed strain-ratio relationship is used in conjunction with the assumption of maximum work during a given strain to calculate the criterion of yield. It is found that this is very close to, but not identical with, the Mises-Hencky criterion.

METALS & ALLOYS

Comparison of Crystal Structures of 10 Wrought Heat Resisting Alloys at Elevated Temperatures with Their Crystal Structures at Room Temperature. J. Howard Kittel. *U.S., N.A.C.A., Technical Note No. 1488*, November, 1947. 11 pp., illus. 2 references.

Crystal structures of wrought high-temperature alloys S-816, S-590, Hastelloy B, 19-9 W-Mo, X-155, 16-25-6, K-42-B, Inconel X, Nimonic 80, and type 347 stainless steel were determined at room temperatures of 1,200°, 1,500°, and 1,800°F. by X-ray diffraction methods and up to 2,150° by thermal-dilatation methods. The only transformation noted was that in 19-9 W-Mo which, when heated, began to transform from a two-phase mixture of body-centered and face-centered cubic structures to a single phase of face-centered cubic structures between 1,400° and 1,450°F.

Effect of Temperature on Fatigue Strength. Hempel. (*PB 14767*, May 25, 1945.) *Cornell Aeronautical Laboratory, Translation*, August, 1947. 10 pp., figs.

The results of preliminary tests of high-temperature and special steels to determine the effect of elevated temperatures on their notch characteristics and their tension-compression fatigue strength. An increase in temperature decreases the notch effect coefficient. With high creep strength, transformations take place under conditions of alternating strain direction at high temperatures which produce a relatively low fatigue strength.

Creep Tests on Chromium Manganese Vanadium Steel Alloys Flw. 1604.2 and 1604.5. Paul Even. (*BMW Flugmotorenbau, G.m.b.H., BMW/EVZ/111–45*, March, 1946.) *U.S., Army Air Forces, Translation No. F-TS-1864-RE*, September, 1947. 4 pp., fig. Laboratory report on materials for gas-turbine blades.

High-Temperature Alloys in Gas Turbines. Sir William Griffiths. *The Aeroplane*, Vol. 73, No. 1899, October 31, 1947, p. 577, fig. (Extended abstract of a paper.)

Errosive Effects of Gun Blast on Materials—Development of a Strong Brittle Alloy. James A. Broadston. *American Society for Testing Materials, Bulletin*, No. 148, October, 1947, pp. 39–46, illus.

Description of development tests of a material suitable for the gun-port doors of high-speed combat aircraft. It required strength and ductility adequate to withstand the repetitive impact, heat, and erosion of the explosive gases at the gun muzzle, and had to be frangible so that in the event of inadvertent firing, the doors would be shot off without damage to the aircraft. Tests of muzzle-blast effect were conducted by North American Aviation, Inc., on various metals, ceramics, and plastics to determine the erosion and temperature resistance required. A high-copper-magnesium-aluminum frangible cast alloy, NAA specification NA2-9906, was selected. Further tests were conducted to develop a corrosion-resistance treatment that would enable the alloy to withstand the corrosive action of the muzzle-blast deposit.

Mechanical Behavior of High Damping Metals. Clarence Zener. *Journal of Applied Physics*, Vol. 18, No. 11, November, 1947, pp. 1022–1024, figs.

The relation between the various measures of internal friction are independent of the precise mechanism of the dissipation of energy when the internal friction is small, but not when it is large. The relation between the two measures most commonly used, logarithmic decrement and tangent of the angle with which strain lags behind stress, is deduced for all levels of internal friction in the important case in which the dissipation of energy is due to a relaxation process having a single time of relaxation. The conditions are further derived under which a specimen of such a metal will not vibrate but return aperiodically to its equilibrium configuration.

Application Tables to Guide in the Selection of Materials. I. Zola Fox. *Product Engineering*, Vol. 18, No. 11, November, 1947, pp. 165, 167, 169.

A list of 36 of the metals most commonly used in machine design, with the applications of the materials, the forms in which it can usually be obtained, and remarks on its limitations and special properties. The list covers wrought carbon steels, wrought stainless steels, wrought steel-alloy steels, wrought copper and nickel alloys, and wrought aluminum alloys.

Standard Steels; Wrought AISI Types. II. *Machine Design*, Vol. 19, No. 11, November, 1947, pp. 151–163, figs.

The hardenability bands and their band limits are given for all steels on which sufficient data are available to establish reasonably authentic bands. The data shown in the maximum and minimum curves for each of the 64 steels are repeated in tabular form, grouped by series.

A Gear and Lubricant Tester—Measures Tooth Strength or Surface Effects. E. A. Ryder. *American Society for Testing Materials, Bulletin*, No. 148, October, 1947, pp. 69–73, illus.

Description of a gear-test rig used by Pratt & Whitney. Two parallel shafts are connected by a Hopkinson coupling. The test specimens are actual gears of the same material as the full scale gear but of simplified design and are mounted one on each of the two coupled shafts. The relative position of the shafts is controlled hydraulically and determines the load placed on the test gears. The coupling and the specimens are in separate compartments and are lubricated independently.

Changes Found on Run-In and Scuffed Surfaces of Steel Chrome Plate, and Cast Iron. J. N. Good and Douglas Godfrey. *U.S., N.A.C.A., Technical Note No. 1432*, October, 1947. 22 pp., illus. 24 references.

Tests were made by X-ray and electron diffraction techniques, microhardness determinations, and microscopy. The principal chemical reactions were oxidation and carburization, which varied with surface wear conditions, as did hardness and apparent crystallite size.

X-Ray Analysis in the Steel Industry; Summarized Proceedings of a Meeting of the X-Ray Analysis Group of the Institute of Physics, Sheffield, 8–9 November, 1946. *Journal of Scientific Instruments*, Vol. 24, No. 10, October, 1947, pp. 266–273, illus. 26 references.

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HERE is the Navy's new transport Helicopter—the Piasecki HRP-1. Suspended in midair, its giant rotors can support four tons of gross weight—can carry nine or ten men to safety in an emergency.

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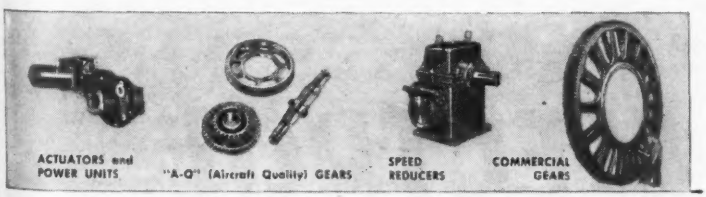

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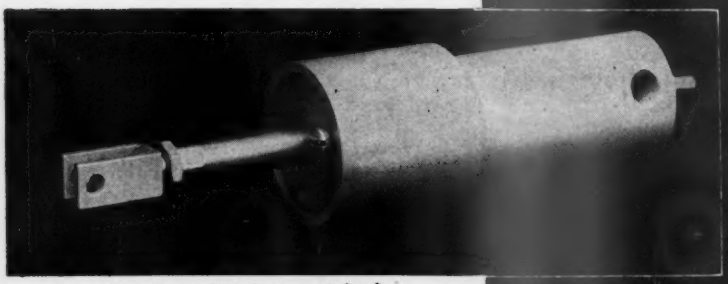

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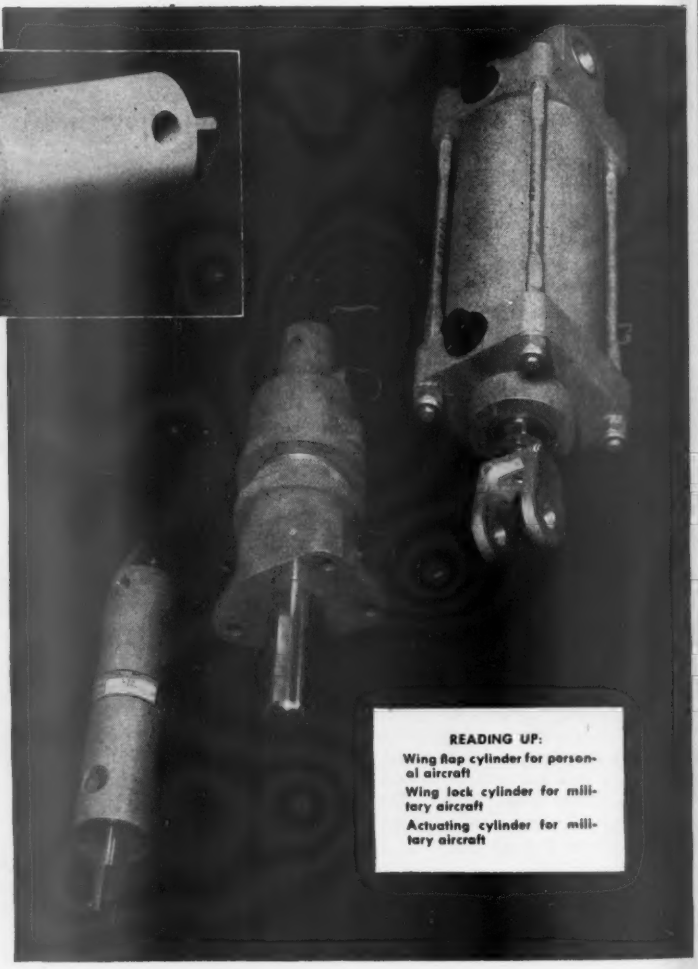

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Comparison of Fluorescent and Magnetic Particle Inspection Methods. Edward Nugger. *U.S., Army Air Forces, Technical Report No. 5598,* June 17, 1947. 9 pp., illus.

Observations on the Control of Grain Size in Magnesium Casting Alloys. Vernon C. F. Holm and Alexander I. Krynitsky. *U.S., National Bureau of Standards, Journal of Research,* Vol. 39, No. 3, September, 1947, pp. 265–270, table. 10 references.

The methods investigated for the control of grain size in magnesium casting alloys were: (1) stirring of the carbonaceous solids into the molten alloy, (2) bubbling of carbon monoxide through the melt, (3) melting in a silicon carbide crucible, and (4) treatment with lump magnesite. In the last method, the magnesite was placed deep in the molten metal, where it dissociated thermally, generating a carbonaceous gas that bubbled through the melt. The grain size and tensile properties were determined on specimens of each melt, and these compared with data from melts that had been superheated as well as those that had received no special treatment. The results indicate that magnesium alloys that have been properly treated with carbonaceous materials possess grain-size and tensile properties equivalent to those obtained in superheated metal. The magnesite method is a simple, inexpensive, and convenient means of developing a fine-grained structure in magnesium casting alloys.

Stress-Strain and Elongation Graphs for Alclad Aluminum-Alloy 75S-T Sheet. James A. Miller. *U.S., N.A.C.A., Technical Note No. 1385,* November, 1947. 36 pp., figs. 6 references.

The graphs presented are drawn from tests of duplicate longitudinal and transverse 0.032-, 0.064-, and 0.125-in.-thick Alclad aluminum-alloy 75S-T sheet specimens of tensile and compressive stress-strain and stress-deviation to a 1 per cent strain, tangent modulus and reduced modulus for a rectangular section against strain in compression, stress strain of tensile specimens tested to failure, and local elongation and elongation against gage length for tensile specimens tested to fracture. The stress-strain, stress-deviation, tangent-modulus, and reduced-modulus graphs are plotted on a dimensionless basis to make them applicable to material with differing yield strengths.

Measurement of Thickness of Oxide Coatings on Aluminum Alloys. Ralph B. Mason and William C. Cochran. *American Society for Testing Materials, Bulletin,* No. 148, October, 1947, pp. 47–51, figs. 5 references.

The Filmeter manufactured by the American Instrument Company is a portable heat-frequency oscillator for measuring coatings and films on conductors. Tests conducted with oxide films of aluminum and aluminum alloys showed that readings could be obtained which were as accurate as those given by microscopic and stripping methods. However, accuracy depended on the flatness and smoothness of the specimen and on the accuracy of the zero setting of the instrument for the specific sample tested. The Filmeter can also be used to give a rough measure of the conductivity of an alloy and in some cases an approximate identification. With proper technique it can serve to detect differences in the thickness of Alclad coating layers on core materials of lower conductivity than the coating.

Shotpeening of Nonferrous Metals. Harold A. Knight. *Materials & Methods,* Vol. 26, No. 5, November, 1947, pp. 83–86, illus.

A summary of the research conducted under the auspices of the O.S.R.D. on the effect of shot peening on the fatigue durability and stress corrosion resistance of nonferrous metals. Identification numbers of reports available through the Office of Technical Services are given.

Age Hardening Heat Treatment of 75 S-T and R303 Aluminum Alloy Sheet Materials. James J. Niehaus. *U.S., Army Air Forces, Technical Report No. 5589,* June 4, 1947. 21 pp., illus.

Further Investigation of Preheating and Postheating in Spot-Welding 0.040-Inch Alclad 24S-T. W. F. Hess and F. J. Winsor. *U.S., N.A.C.A., Technical Note No. 1440,* December, 1947. 13 pp., figs. 3 references.

The Intermetallic Compound Phases of the System Aluminum-Manganese-Zinc. G. V. Raynor and D. W. Wakeman. *Royal Society of London, Proceedings, Series A,* Vol. 190, No. 1020, June 17, 1947, pp. 82–101, 2 pp. plates. 12 references.

Fabrication of Aluminum in Germany; A Study of Some Specialized Practices and Technique Employed in the Industry. C. F. Nagel, Jr., B. C. McFadden, and G. D. Welty. *U.S., Field Information Agency, Technical, Final Report No. 1011,* August 4, 1947. 29 pp. 28 references. British Information Services, New York. $1.00.

Cold Impact Extrusion of Aluminum, Etc. F. A. Stroud. *Gt. Brit., British Information Objectives Sub-Committee, Final Report No. 1409, Item No. 21,* August, 1946. 33 pp., diagrs. British Information Services, New York. $0.35.

The Light Metals Control Association (Japan). *Gt. Brit., British Intelligence Objectives Sub-Committee, Report No. B.I.O.S./J.A.P./P.R./1353.* 21 pp. New York, British Information Services. $0.70.

NONMETALLIC MATERIALS

A Critical Temperature Range in the Plastic Deformation of Plywood. H. G. Higgins. (*Australia, Council for Scientific and Industrial Research, Journal,* Vol. 19, No. 4, November, 1946, pp. 455–462.) *Engineers' Digest,* Vol. 4, No. 10, October, 1947, pp. 469, 470, figs.

Plywood sheets were subjected to compression loads ranging from 200 to 1,300 lbs. per sq.in. at temperatures ranging from 120° to 200°C. Moisture content as low as 7 to 8 per cent was found to increase the plastic flow. The plasticizing action appears to be due to the action of steam. With rising temperatures the yield value declines from 120° to 160°C. Since above 160° this value remains low, it may be taken as being in the mode of plastic deformation.

Wood and Glues in Aircraft; A Review of the Problems of Specification, Inspection and Procurement. Don Brouse. *U.S., Army Air Forces, Technical Report No. 5544,* January 31, 1947. 47 pp. 49 references.

Wear Tests of Plastics. N. N. Sawin. (*Maschinenbau und Wärmewirtschaft,* Vol. 1, No. 5–6, November–December, 1946, pp. 103–108.) *Engineers' Digest,* Vol. 4, No. 10, October, 1947, pp. 451–454, diagrs.

Tests on phenolic and formaldehyde laminated material, plywood, and scrap plywood, in which the synthetic resin was the basic constituent, were made with a Skoda-Sawin machine. The load on the tungsten-titanium carbide wheel of the machine could be varied between 0 and 55 lbs. The speed of the wheel could be varied from 0.4 to 8 ft. per sec. After a specified number of revolutions the specimen was examined with a microscope, and the volume of the impression made by the wheel was used as an index of wear. The powdered wear particles of the test bar act as the principal factor in the formation of the impression. The carbide acts as the base or carrier for the wear particles. The wear values obtained thus characterize the wear of a synthetic material by its own wear particles. As the speed of the wheel increased up to 5 ft. per sec., the wear decreased, reaching its minimum value. Wear increased in direct proportion to the load on the wheel and the number of revolutions. The most advantageous wear condition with a sintered carbide wheel was found to be 11 lbs., 3,281 ft. per sec, and 3,000 revolutions for all types of plastics examined.

Fungus Resistance of Rubber Cork Composition Tape Specification 12023. Francis Czarnecki. *U.S., Army Air Forces, Technical Report No. 5588,* May 29, 1947. 19 pp., illus.

Treatment of Nylon Webbing to Increase Resistance to Abrasion. C. A. Willis. *U.S., Army Air Forces, Technical Report No. 5590,* June 13, 1947. 6 pp., illus.

Properties of the Synthetic Rubbers. P. J. Mahoney, J. I. Wittebort, and C. E. Jaynes. *U.S., Army, Air Corps, Technical Report No. 4860,* November 21, 1942. 23 pp., figs. 3 references.

Natural rubber can be replaced by a synthetic rubber for practically all uses and types of installations. Synthetic rubbers excel natural rubber in resistance to aging, weathering, and sunlight, and in resistance to the effect of oils and gasolines. Natural rubber excels in elasticity, rebound, low heat build-up through hysteresis, and in resistance to stiffening at low temperatures.

SANDWICH MATERIALS

Development of Air Materiel Command AT-6C Glass Outer Wing Panel. *U.S., Army Air Forces, Technical Report No. 5576,* April 23, 1947. 185 pp., illus. 12 references.

Detailed account of a research program to develop a glass wing panel. A sandwich construction was evolved that consists of a core made of glass cloth and faces of twelve-ply glass cloth. Plaskon 911, a low-pressure resin, impregnated the glass fibers and bonded the assembly. The strength-weight characteristics of the wing compared favorably with conventional aluminum-alloy structures. Since the sandwich skin will not buckle or wrinkle up to ultimate load, the airfoil should maintain maximum aero-

dynamic efficiency under all flight conditions. The method of fabrication is simple in comparison with metal fabrication. The simple design and reduction in the amount of tooling required will reduce production time and costs.

Meteorology

Objective Methods of Forecasting Winter Minimum Temperatures at Washington, D.C. Conrad P. Mook and Saul Price. *U.S., Weather Bureau, Research Paper No. 27*, August, 1947. 38 pp., figs. 3 references.

The N.Y.U. method of forecasting air trajectories locates the body of air which is expected to arrive at the observation station 24 hours hence. The modification in temperature of this air during an overland journey is taken as a linear function of its current departure from normal, its latitude, and the difference between its current temperature and the temperature of the observation station. The constants for the equation relating these variables are determined by least squares. A 30-hour rather than a 24-hour time lapse was used. The results of experiments using a 30-hour lapse showed the need for basic research into the tracing of air currents.

Captive-Balloon Equipment for Low-Level Meteorological Soundings. Lloyd J. Anderson. *American Meteorological Society, Bulletin*, Vol. 28, No. 8, October, 1947, pp. 356–362, illus. 2 references.

Description of equipment used in a wired-sound system for taking meteorological and propagation data up to altitudes of 3,000 ft. The calibration of the elements, circuit diagrams, and performance curves.

An Airplane Psychograph. Isadore Katz. *American Meteorological Society, Bulletin*, Vol. 28, No. 8, October, 1947, pp. 363–370, illus. 7 references.

Detailed description of an instrument that employs ceramic resistors as wet and dry elements to measure sharp gradients of temperature and water vapor present in the lowest several thousand feet of the atmosphere. The measurements are necessary for an understanding of the phenomena causing anomalous propagation associated with the ultra-high frequencies used for radar.

Notes on the Theory of Tropical Cyclones. J. S. Sawyer. *Royal Meteorological Society, Quarterly Journal*, Vol. 73, No. 315–316, January–April, 1947, pp. 101–126, diagrs. 9 references.

A theoretical investigation of the stability of circular vortexes to determine under which conditions continued outward motion is possible. The removal of air from the storm center of a tropical cyclone is explained by a lapse rate that gives rise to vertical instability and the development of a convection cloud. A distribution of circulation must exist at some level aloft such that anticyclonic circulation increases outward at a rate exceeding a certain value. A distribution in the vertical of horizontal rotation must also exist such that cyclonic circulation decreases with height.

The Coastal Sea Breeze in Relation to Diurnal Temperature Changes in the Lower Atmosphere (Southern California). Luna B. Leopold and Charles G. P. Beer. *American Meteorological Society Bulletin*, Vol. 28, No. 8, October, 1947, pp. 371–380, diagrs. 4 references.

Weather Forecasts. E. Gold. *Royal Meteorological Society, Quarterly Journal*, Vol. 73, No. 315–316, January–April, 1947, pp. 151–185, 16 folding charts.

An outline of the arrangements whereby the forecaster obtains data; observation; the collection, manipulation, and analysis of data; the forecast itself; and the issuance and utilization of forecasts for general and special purposes.

An Investigation of Subsidence in the Free Atmosphere. Sverre Petterssen, P. A. Sheppard, C. H. B. Priestly, and K. R. Johannessen. *Royal Meteorological Society, Quarterly Journal*, Vol. 73, No. 315–316, January–April, 1947, pp. 43–64, tables. 6 references.

A theoretical and statistical investigation of nonorthographic subsidence. The changes in potential temperature, humidity mixing ratio, and the potential wet-bulb temperature which are characteristic of the air mass are derived theoretically. Over a period of 5 months subsidence was pronounced on 54 days. The data obtained were analyzed in an attempt to correlate subsidence with the synoptic situations at sea level and aloft.

The Thunderstorm High. W. Schaeffer. *American Meteorological Society, Bulletin*, Vol. 28, No. 8, October, 1947, pp. 351–355, figs. 7 references.

Dynamical Control of Atmospheric Pressure. C. H. B. Priestly. *Royal Meteorological Society, Quarterly Journal*, Vol. 73, No. 315–316, January–April, 1947, pp. 65–84, figs. 10 references..

A discussion of the control of pressure and the consequent behavior of pressure patterns in a field of motion in which the centrifugal, deviating, and pressure forces are at all times balanced.

Atmospheric Oscillations and the Resonance Theory. K. Weeks and M. V. Wilkes. *Royal Society of London, Proceedings, Series A*, Vol. 192, No. 1028, December 23, 1947, pp. 80–99, fig. 32 references.

Physical considerations, mathematical theory, the temperature variation with height in the atmosphere, observational data relating to the oscillation of the atmosphere, free periods of the atmosphere, and the resonance characteristics of simple model atmospheres.

The Basic Reactions in the Upper Atmosphere. II—The Theory of Recombination in the Ionized Layers. D. R. Bates and H. S. W. Massey. *Royal Society of London, Proceedings, Series A*, Vol. 192, No. 1028, December 23, 1947, pp. 1—16, figs. 24 references.

Turbulence and Diffusion in the Lower Atmosphere With Particular Reference to the Lateral Effect. D. R. Davies. *Royal Society of London, Proceedings, Series A*, Vol. 190, No. 1021, July 8, 1947, pp. 232–244, figs. 5 references.

Night Cooling of the Ozonosphere. E. H. Gowan. *Royal Society of London, Proceedings, Series A*, Vol. 190, No. 1021, July 8, 1947, pp. 227–231, fig. 13 references.

Ozonosphere Temperatures Under Radiation Equilibrium. E. H. Gowan. *Royal Society of London, Proceedings, Series A*, Vol. 190, No. 1021, July 8, 1947, pp. 219–226, figs. 38 references.

Vertical Transport of Heat by Turbulence in the Atmosphere. C. H. B. Priestley and W. C. Swinbank. *Royal Society of London, Proceedings, Series A*, Vol. 189, No. 1019, June 3, 1947, pp. 543–561, figs. 15 references.

Atmospheric Tides in the Ionosphere. I—Solar Tides in the F2 Region. II—Lunar Tidal Variations in the F Region Near the Magnetic Equator. D. F. Martyn. *Royal Society of London, Proceedings, Series A*, Vols. 189, 190, Nos. 1017, 1021, April 17, July 8, 1947, pp. 241–260; 273–288, figs. 18, 4 references.

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Radiative Equilibrium in the Ionosphere. R. v. d. R. Woolley. *Royal Society of London, Proceedings, Series A*, Vol. 189, No. 1017, April 17, 1947, pp. 218–240, fig. 21 references.

Weather Research; Quarterly Report. *General Electric Research Laboratory*, October, 1947. 37 pp., illus.

A complete history through October, 1947, of research on the artificial production of snow and rain. The research was conducted by the Research Laboratory of the General Electric Company under the joint auspices of the office of Naval Research, the Air Force, and the Signal Corps. A general survey is given of the laboratory, photographic, and flight-test aspects and the personnel of the project. The basic report summarizes the results that have thus far been obtained in the nucleation of clouds. A second report describes the techniques developed in conducting these experiments. In addition to the standard aircraft instruments it was found necessary to develop or adapt for these experiments an automatic dry-ice dispenser, icing-rate exposure rods, a clinometer attachment for cameras, a modification of Schaefer's cloud meter which uses a porous plug collector to measure the liquid-water content of clouds, a glass rod exposure gun and air decelerator for checking the droplet size, and an accelerometer, altimeter, and elevation-position recorder. Preliminary research has been done on the nucleation of ice formation by silver iodide particles. The report includes typical data obtained from photographs of a seeded area.

Sublimation in a Wilson Chamber. B. M. Cwilong. *Royal Society of London, Proceedings, Series A*, Vol. 190, No. 1020, June 17, 1947, pp. 137–143, diagrs. 10 references.

Discharge Currents Associated With Kite Balloons. T. Davis and W. G. Standring. *Royal Society of London, Proceedings, Series A*, Vol. 191, No. 1026, November 18, 1947, pp. 304–322, illus. 10 references.

Progressive Lightning. VII—Directly-Correlated Photographic and Electrical Studies of Lightning From Near Thunderstorms. D. J. Malan and B. F. J. Schonland. *Royal Society of London, Proceedings, Series A*, Vol. 191, No. 1027, December 3, 1947, pp. 485–503, 2 pp. plates. 13 references.

Operations

COMMERCIAL

Nationales Zivilflugwesen und Internationale Luftverkehr der Schweiz; Jahresstatistik 1946 (National Civil Aviation and International Air Transport of Switzerland; Statistics for the Year 1946). *Schweizer Aero-Revue*, Vol. 22, No. 8, August, 1947, pp. 336, 337, tables. Some figures for 1945 are included for comparison.

American Air Cargo Development. John H. Frederick. *Air Affairs*, Vol. 2, No. 1, Autumn, 1947, pp. 79–100. A detailed history. Emphasis is placed on the ground-service factor, which roughly divides the development into three periods; 1926, 1926–1945, and 1945 to date.

Aircraft and the Air Lines. J. T. Bain. *The Aeroplane*, Vol. 73, No. 1900, November 7, 1947, pp. 618–621, illus. (Extended abstract of a paper: "Aircraft and the Air Lines—A Canadian View.")

Aircraft and the Airways. James T. Bain. *Flight*, Vol. 52, No. 2028, November 6, 1947, pp. 530, 531, 533. (Extended abstract of a paper.) A survey of the operating problems of North American air lines.

Sabena; A Prosperous Air Line. *The Aeroplane*, Vol. 73, No. 1899, October 31, 1947, pp. 591, 592, illus.

Air Services in Britain; London and the South-West; The Effort of Provincial Airways. *Modern Transport*, Vol. 58, No. 1492, November 1, 1947, p. 7, illus.

South Africa Now Witnessing Big Air-Line Service Growth; Union's Government and Privately Owned Lines Expanding. E. H. Bourgerie. *Foreign Commerce Weekly*, Vol. 29, No. 5, November 1, 1947, pp. 5, 34, illus.

Geography and Aviation. Ellsworth Huntington. *Air Affairs*, Vol. 2, No. 1, Autumn, 1947, pp. 46–60.

Ordnance & Armament

Fragmentation Effectiveness of Bombs. Helias. (*ZWB/E'Stelle Report 1509/43*, December 20, 1943.) *Cornell Aeronautical Laboratory, Translation*, November, 1947. 8 pp., fig.

An analysis of the relations between the effective coverage of a fragmentation bomb and the trajectory of the fragments, the trajectory of the bomb, the release altitude, and the locus of the bomb at detonation.

Offensive Support; R.A.F. and Naval Aviation Demonstrate Air Weapons. *Flight*, Vol. 52, No. 2026, October 23, 1947, pp. 468, 469, illus.

Investigation for the Development of a High-Speed Antiaircraft Tow Target. Eugene Migotsky. *U.S., N.A.C.A., Memorandum Report (Wartime Report No. L-760)*, July, 1943. 35 pp., illus. 4 references.

Fragmentation of Shell Cases. N. F. Mott. *Royal Society of London, Proceedings, Series A*, Vol. 189, No. 1018, May 1, 1947, pp. 300–308, diagrs. 1 reference.

A Theory of the Dependence of the Rate of Detonation of Solid Explosives on the Diameter of the Charge. *Royal Society of London, Proceedings, Series A*, Vol. 189, No. 1018, May 1, 1947, pp. 415–426, figs. 3 references.

The velocity of a detonation wave, in a cylindrical charge of solid explosive, is shown to be dependent on the diameter of the charge, and the relation between the velocity and the diameter is calculated. It is shown that this effect depends upon the rate of the chemical reaction occurring in the front portions of the detonation wave, and that it is possible, therefore, to determine this rate of reaction by measuring the velocity of detonation in bare charges of different diameters. The effect of a metal case surrounding the charge is briefly discussed.

Parachutes

Super-Sonic Testing Gun. *Plane Facts*, Vol. 4, No. 3, August, 1947, pp. 16–18, diagrs.

Description of a proposed compressed-air gun that will make possible the systematic measurement of the trajectory, motions, and curve of deceleration over time and distance of parachutes, ejection seats, and other objects, at speeds up to Mach Number 2. The projectile will be designed so as to eject the model parachute immediately upon clearing the gun barrel. An oscillograph will show the deceleration of the projectile at the muzzle.

Parachute Test Tower (Being Built by the A.F. Materiel Command). *Plane Facts*, Vol. 6, No. 4, October, 1947, p. 20, diagr.

Personnel

The Airplane Pilot: A Survey of the Critical Requirements of His Job and of Pilot Evaluation and Selection Procedures. Thomas Gordon. *U.S., Civil Aeronautics Administration, Division of Research, Report No. 73*, November, 1947. 149 pp.

A summary of analyses of critical incidents reported by pilots, inspectors, and check-pilots provide 787 examples of pilot behavior. The three most important requirements for the pilot's job were found to be the skills required to establish and maintain a proper angle of glide, rate of descent, and speed of glide on the approach; the operation of controls and switches; and navigating and orienting. Applicants who successfully completed pilot training were compared with a matched group of those applicants who were dropped. Comparison of the groups was made on the basis of age, education, and flying hours at time of employment; scores on standardized intelligence and personality tests; and performance in ground and flying training. Since the selection requirements of the air lines do not in general predict the later success or failure during training, they were considered not to be critical requirements. The survey provides a foundation on which to develop improved selection, more appropriate training, and more objective evaluation of the air-line pilot.

Analysis of CAA Records on Airline Transport Pilots. H. O. Preston. *U.S., Civil Aeronautics Administration, Division of Research, Report No. 72*, August, 1947. 40 pp.

An analysis of the records for 1,278 pilots failed to show any consistent pattern of performance in the different written and flight examinations administered by the C.A.A. at different stages of the career of the civil air-line pilot. However, a positive relationship was found between scores on first attempts to pass the written tests for private and commercial certificates, and a negative relationship was found between the scores on the flight tests for these same certificates. Pilots with military experience were found to pass the flight test for the air-line transport certificate as

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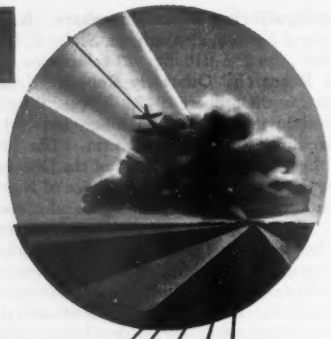

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frequently as pilots with no military experience. On the written test for this certificate, however, the military group made significantly lower scores. The lower scores were attributed to a temporary unfamiliarity with civil regulations.

Photography

Application of the Direction-Cosine System of Analysis to Scale-Data Problems in Aerial Photogrammetry. Earl Church. *Syracuse University, Syracuse, N. Y., Department of Photogrammetry, Bulletin No. 18*, September, 1947. 22 pp.

Power Plants

Future Trends in Aircraft-Engine Design. A. T. Gregory and A. L. Pomeroy. *SAE Quarterly Transactions*, Vol. 1, No. 4, October, 1947, pp. 529–548, 558, diagrs.

A canvass of a number of aircraft, aircraft-power-plant, and fuel-and-lubricant engineers indicates that the reciprocating engine will occupy first place among aircraft power plants for the next 10 years. Turboprops will gradually displace reciprocating engines in transports and bombers. Turbojets will become common in fighters. But small aircraft will still be relying on reciprocating engines in 1957.

Don't Pass up the Piston—It's Got a Long Life Yet. *Aircraft and Airport*, Vol. 9, No. 9, 1947, pp. 26, 28–32, 50, illus. Illustrations and descriptions of 51 American and British reciprocating and jet engines, and tabulated specifications.

JET & TURBINE

Gas Turbine for Civil Aircraft. E. L. Bass. *Shell Aviation News* (London), No. 112, October, 1947, pp. 15–22, illus.

A broad outline of the development trends of the gas-turbine engine, giving a brief description of the design and characteristics of the turboprop and the pure jet engine. The eventual establishment of the gas-turbine engine as the principal power plant for both military and civilian aviation awaits the solution of problems presented by the design and the materials to be used in compressors, turbines, and combustion chambers and also the solution of such problems in its employment as airport design and traffic control.

Horizons in Jet Power. F. Zwicky. *Ordnance*, Vol 32, No. 165, November–December, 1947, pp. 157–159, illus.

An outline of the application to propulsive power of the morphological method of planning and correlation. This type of analysis reveals the multiplicity of devices that may be invented to utilize this power.

Development and Testing of a Gas-Turbine Combustor. A. E. Hershey. *American Society of Mechanical Engineers, Transactions*, Vol. 69, No. 8, November, 1947, pp. 859–867, illus. 4 references.

Summary of development work on a combustor for a 2,200-hp. gas turbine. The design was of open cycle without regenerator or intercooler. The number 6 or bunker C fuel which was to be used required a flame igniter. The final design made it possible to light up with the igniter at conditions corresponding to starting operation for the unit and run through a sequence of test conditions corresponding to idling, full-load, and partial-load conditions with the igniter extinguished. The maximum air-fuel ratio measured during steady-state operation was 192 to 1.

Description and Performance Tests of Jumo-004B Turbojet Engine (Project No. DP-139). C. H. Martens. *U.S., Army Air Forces, Technical Report No. F-TR-1152-ND (GS-AAF-Wright Field No. 65)*, December, 1947. 178 pp., illus.

Reaction-Powered Planes and Missiles. *Aero Digest*, Vol. 55, No. 5, November, 1947, pp. 44–46, illus. A summary of the ramjet, turbojet, and turboprop engines developed to date. American and British aircraft employing these engines are listed.

British Gas Turbines. *The Aeroplane Spotter*, Vol. 8, No. 199, November 1, 1947, pp. 246, 247, illus. Specifications and illustrations of ten standard production units.

RECIPROCATING

The Variation With Air Temperature of Aircraft Performance, Engine Power and Temperature, and Fuel Flow, as Determined by Flight Tests on a Lancaster I. W. J. D. Annand. *Gt. Brit., Aeronautical Research Council, Reports and Memoranda No. 2169*, November, 1944. 27 pp., figs. 5 references. British Information Services, New York. $1.50.

Theory and Tests of Air-Ejector Compressor Dynamic Couple to Improve Supercharger Stability and Range. Hugh E. Gommel. *U.S., Army Air Forces, Technical Report No. 5575*, April 21, 1947. 52 pp., illus. 18 references.

A method of increasing the range of stable operation of a supercharger. When the flow through the compressor approaches the unstable range, air is bled from the discharge, passed through an intercooler, and ejected into the intake orifice of the impeller. The momentum from the discharge of the air ejector maintains the stable operating range of the supercharger.

Some Rules for the Design of Superchargers with High Compression Ratios. C. Pfleiderer and W. Thuss. (*ZWB/FB 1981*, May 18, 1944.) *Cornell Aeronautical Laboratory, Translation*, June, 1947. 23 pp., figs.

Methods of calculating for superchargers with high compression ratios and flows which approach the speed of sound. The high compression ratios require correspondingly high velocities at the impeller inlet or at the exit. These velocities have considerable effect on the density changes that take place and hence on the dimensions of the unit. The optimum dimensions of the rotor inlet are derived and the design of the volute is calculated for pressure increasing outward. Curves and tables are developed from which the correct relationships for the impeller can be read directly.

An Investigation of Valve-Overlap Scavenging Over a Wide Range of Inlet and Exhaust Pressures. John W. R. Creagh, Melvin J. Hartmann and W. Lewis Arthur, Jr. *U.S., N.A.C.A., Technical Note No. 1475*, November, 1947. 23 pp., diagrs. 4 references.

A single-cylinder engine was investigated with valve overlaps of 40° and 130° over a range of exhaust-to-inlet-pressure ratios from approximately 0.1 to 1.3 at engine speeds of 2,000, 2,500, and 2,800 r.p.m. Cylinder-clearance volume could be completely scavenged but with an accompanying loss of fresh charge air. Some improvements in cooling of exhaust-valve guide were obtained.

Slant Mechanisms—Principles and Application. T. L. Sherman. *Machine Design*, Vol. 19, No. 11, November, 1947, pp. 135–140, 186, diagrs.

The design, history, and development of the Michall-Crankless mechanism. The basic type of this engine consists of a guided reciprocating piston unit engaging, by means of universally mounted slipper elements, with flat surfaces obliquely disposed to the axis of a power shaft. The design was applied to an opposed-piston Diesel aircraft engine of 2,000-hp. take-off capacity, which was to weigh 1 lb. per hp. The torque reaction system that was finally developed, the difficulties of slant design, and the solution of the problem presented by the slipper pads are analyzed in detail.

Power-Plants for Helicopters; Weight, Speed, Mounting and Cooling Are the Problems. *Flight*, Vol. 52, No. 2026, October 23, 1947, p. 470, diagrs.

BMW-803 Engine. C. E. Clutter. *U.S., Army Air Forces, Technical Report No. 5585*, May 13, 1947. 78 pp., illus.

A detailed record of the design, engineering, and operational characteristics of the BMW 803 aircraft engine.

Rolls-Royce "Eagle" Engine; Design Details of Britain's Most Powerful Piston Engine. *Engineering Journal*, Vol. 30, No. 10, October, 1947, pp. 483, 484, illus.

Controlled Friction. *Machine Design*, Vol. 19, No. 11, November, 1947, pp. 117–119, diagrs.

The design and development of a multiple-disc clutch for use with high torque aircraft engine starters. Jack & Heintz Precision Industries, Inc., used hard-steel discs operating against plain phosphor bronzes and increased the number of oil reservoir holes. Chatter and rough operation were eliminated by adding to the lubricant a fine pulverule hard material that exercised a continuous polishing action on the surface of the plate and produced microscopic lubricant-retaining grooves.

Metallurgical Examination of Japanese Roller-Bearing Assemblies from Aircraft Engine "Zeke." H. W. Gillett, A. S. Henderson, and others. *Gt. Brit., British Intelligence Objectives Sub-Committee, Report No. B.I.O.S./J.A.P./P.R./1441*, November 1, 1943. 15 pp., illus. British Information Services, New York. $0.55.

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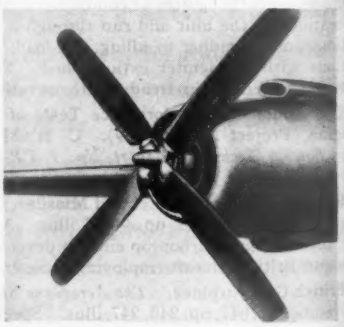

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ROCKET

Liquid-Propellant Rocket Power Plants. M. J. Zucrow. *American Society of Mechanical Engineers, Transactions*, Vol. 69, No. 8, November, 1947, pp. 847–856, Discussion, pp. 856, 857, diagrs.

A general discussion. In order to utilize the full potentialities of this means of propulsion, cooling methods must be developed which will permit existing propellants to operate at higher combustion-chamber pressures. Research must also be directed to raising the ratio of the combustion temperature to the molecular weight of the propellant. Control systems must be designed to give greater reliability and improved materials must be found for valve seats, packings, and pump seals. The interior ballistic equations of the rocket motor are derived, and the physical characteristics of the V-2 missile, the component weight of the Walter power plant, and the characteristics of multiple-step escape rockets are tabulated.

Rocket Engine Developments. Roy Healy. *Aero Digest*, Vol. 55, No. 5, November, 1947, pp. 38–41, 116, 119, 120, illus. A general outline of basic rocket-propulsion systems and a detailed description of the designs that have been employed in the elements of the systems.

Nazi Rocket Research; Enemy Attempts to Find an Adequate Substitute for Artillery and Bombers. Albert L. Ruiz. *Ordnance*, Vol. 32, No. 165, November–December, 1947, pp. 165. 166, illus.

'Super Husky' Air Ambulance Uses JATO. *Aircraft and Airport*, Vol. 9, No. 9, September, 1947, pp. 20, 52, 53, illus. Installation of Aerojet Model 12AS-1000D-5 units on a Fairchild "Husky."

Rocket Propulsion; Improved Aircraft Rocket Engines. K. W. Gatland. *Newnes Practical Mechanics*, Vol. 14, No. 167, September, 1947, pp. 385–387, illus. A description of the rocket motors developed in Germany by Walter and the BMW to provide fighter aircraft with auxiliary thrust.

Rocket Propulsion; The Transatlantic Rocket. K. W. Gatland. *Newnes Practical Mechanics*, Vol. 15, No. 168, October, 1947, pp. 15–18, illus. Tabulation and description of the rocket missiles developed in Germany between 1933 and 1945.

Production

Machining Turbine Blades. I—Specialized Equipment for Turning, Grinding or Milling Efficient Profiles. T. A. Kestell. *Aircraft Production*, Vol. 9, No. 109, November, 1947, pp. 412–415, diagrs.

The Kestell blade-profiling machine, developed for Power Jets, Ltd., is a constant-orbit mechanism. A cam correction is applied to modify the orbit to give the exact profile. The work shaft is driven at constant speed through a train of gears arranged in planetary form, and the shaft is supported in bearings in an eccentric sleeve so that the center of the shaft is above the center of the sleeve. This arrangement makes it possible to impart simultaneously a rocking and a rotary motion to the work. The profiling operations, the grinding of the convex surface, and the design of the wheel dresser are described in detail.

Slitting Rotating Work; Unconventional Automatic Tooling by A. C. Wickman, Ltd. *Aircraft Production*, Vol. 9, No. 109, November, 1947, p. 416, diagrs.

The Spot Welding of Alclad 24S-T in Thickness of 0.064, 0.081, and 0.102 Inch. W. F. Hess, R. A. Wyant, and F. J. Winsor. *U.S., N.A.C.A., Technical Note No. 1411*, November, 1947. 25 pp., illus. 4 references.

High-strength spot welds, free from cracks, expulsion, and excessive sheet separation in 0.064-in. material were obtained with 4-in. spherical radius electrode tips over a wide range in welding current for optimum conditions. With the same tip contour for optimum conditions, high quality welds were obtained over a narrower current range in 0.081-in. material. Tests of this thickness with 6-in. radius domes to produce stronger, good quality welds were limited by the equipment. Spot welds in 0.102-material with 4-in. radius domes evidenced unsatisfactory cracking. The use of larger dome tips appeared necessary, but was prevented by equipment limitations.

The Flash Welding of Structural Aluminum Alloys. R. M. Curran and R. C. Becker. *Welding Journal*, Vol. 26, No. 11, November, 1947, pp. 664-s–672-s, diagrs. 2 references.

Three-stage heat control was used during the welding cycle. This avoided butting at the start of flashing, eliminated coarse flashing during the remainder of the flashing cycle, and reduced the extent of upset caused by upset current flow. A greater upset travel distance was employed than is the practice with other materials. These techniques appeared necessary to eliminate the oxide formed during the flash cycle from the final weld line. By welding the hard tempers rather than annealed aluminum alloys, joint efficiencies exceeding 90 per cent were obtained. Full sheet strength was obtained by heat-treating after welding.

Shot-Peening Aluminum Forgings. Charles H. Wick. *Machinery*, Vol. 54, No. 3, November, 1947, pp. 133–139, illus.

A detailed description of the shot-peening process adopted by the Pratt & Whitney Aircraft Division of United Aircraft Corporation. This surface-hardening technique has been applied to aluminum-alloy pistons and crankcase sections. Methods of calibrating and controlling the process are suggested.

Blind Riveting Into Heavy-Section Solid Material; The Blackburn-Tharra System. *Aircraft Production*, Vol. 9, No. 109, November, 1947, p. 422, diagr.

The rivet has a headless shank bored at one end to receive a plug with a biconical head. After being plugged, the rivet is inserted in a counterbored hole and driven home. The tail of the shank is thus expanded into the counterbore.

Materials and Methods Manual 31: Resistance Welding. R. T. Gillette. *Materials & Methods*, Vol. 26, No. 5, November, 1947, pp. 97–108. 29 references.

Causes of Diecasting Irregularities. James L. Erickson. *The Iron Age*, Vol. 60, No. 20, November 13, 1947, pp. 82–87, 151, illus. 5 references.

A description of the various types of surface irregularities and discontinuities in the metallic structure of the casting which can be caused by irregularities in the surface, improper design of the die, or by improper control of injection pressure, casting temperature, and rate of cooling.

Causes of Die-Casting Irregularities. James L. Erickson. *Iron Age*, Vol. 160, No. 22, November 27, 1947, pp. 80–86, illus. Explanations and suggestions for the elimination of the common irregularities that affect the dimensional tolerance, mechanical properties, and machinability of die castings.

Manufacture of Precision Castings. G. Vennerholm and E. Ensign. *SAE Quarterly Transactions*, Vol. 1, No. 4, October, 1947, pp. 640–649, illus. 5 references. A comprehensive review of various methods: die casting, permanent-mold casting, investment molding, plaster molding, and various combinations of these methods.

Why Cast Steel Centrifugally? J. F. B. Jackson. *Iron Age*, Vol. 160, No. 22, November 27, 1947, pp. 64–69, illus.

A summary of the characteristics of the centrifugal casting process and the extent of its application; the advantages and disadvantages of the process with respect to flexibility; and the size, grain structure, and soundness of the castings.

A Realistic Appraisal of the Precision Investment Casting Process. W. O. Sweeny. *Iron Age*, Vol. 160, No. 19, November 6, 1947, pp. 86–90, illus.

A summary of the dimensional limitations that obtain in castings of high melting point alloys cast by production methods. The cost of castings can be reduced by allowing the widest possible tolerances, by modifying the design to accommodate this casting method, and by specifying the broadest possible inspection standards.

Tensile Applicator for Aircraft Bolts. Harry W. Sedam. *U.S., Army Air Forces, Technical Report No. 5599*, June 24, 1947. 9 pp., illus.

The desired tension is preset in the instrument. As the nut is tightened the tension in the instrument is relieved, providing an accurate indication of the tensile load developed in the bolt.

Sensitive Pressure Indication with Tone Stylus. *Product Engineering*, Vol. 18, No. 11, November, 1947, pp. 98, 99, illus.

A tracer head for use with manual profile milling machines contains a vibrating wire element. The tension of the wire is determined by the pressure exerted on the stylus. Change in tension causes a change in the natural frequency of the wire. The pitch emitted by an audio amplifier system responds to the change in frequency of the wire. By maintaining a constant pitch in the loudspeaker the operator can rapidly and accurately duplicate deep contours and thin walls such as those found in supercharger impellers.

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Testing Angular Divisions. C. O. Taylerson. *Aircraft Production*, Vol. 9, No. 109, November, 1947, pp. 430–432, illus.

A method of calibrating precision angular measuring instruments in which the angles are read directly on a circular glass scale. The error in these instruments arises from the minute eccentricity of the scale with respect to the axis of rotation of the table. Steel discs with peripheral reflecting surfaces inclined successively at angles of 30° are placed on the turntable so that the setting of the table and the reflected image of the illuminated fixed vertical cross wire of an autocollimator both read zero. The table is turned to a setting of 30°, and the error in the reading of the collimator is the error of the scale. The principle of the autocollimator and the method of calibrating the standard polygons and the graticule of the microscope are explained.

Form-Dressing of Grinding Wheels; A Practical Comparison of the Methods Employed; Tools and Machines; Economic Considerations. W. A. Carter. *Aircraft Production*, Vol. 9, No. 109, November, 1947, pp. 407–411, illus.

Experimental Study of Cylindrical Grinding. R. E. McKee, R. S. Moore, and O. W. Boston. *American Society of Mechanical Engineers, Transactions*, Vol. 69, No. 8, November, 1947, pp. 891–896, figs.

Results obtained with a standard Cincinnati No. 2 cylindrical grinder and hardened S.A.E. 52100 steel. Data given on surface finish with various table traverses, grinding wheels with differing grain sizes, and different cutting fluids.

Convair Production Techniques. *Western Flying*, Vol. 27, No. 11, November, 1947, pp. 18, 19, 26, illus.

Compressed Air Employed in Many Ways in "Convair-240" Assembly. *Steel Processing*, Vol. 33, No. 10, October, 1947, pp. 606–608, illus.

Northrop Flying Wing; Building the B-35 and B-49 Aircraft: A Survey of Manufacturing Problems. D. G. Leland. *Aircraft Production*, Vol. 9, No. 109, November, 1947, pp. 417–422, illus.

Operation Brabazon; Successful Removal of the Prototype Bristol 167 to New Assembly Hall. *Aircraft Production*, Vol. 9, No. 109, November, 1947, pp. 403–406, illus.

Moving the Bristol "Brabazon I." *The Engineer*, Vol. 184, No. 4786, October 17, 1947, pp. 363, 364, illus.

Technical Difficulties of Aero Engine Production in Australia. D. O. MacFarlane. *Aircraft*, Vol. 26, No. 1, October, 1947, pp. 25, 26, 36, 38.

An Indian Aircraft Industry? Large and Well-Equipped Wartime Repair Factories; Their Possibility in Peace. B. Kaiser. *Aircraft Production*, Vol. 9, No. 109, November, 1947, pp. 433–434, illus.

Factory Control at a Glance. Kelcy Kern. *Aero Digest*, Vol. 55, No. 5, November, 1947, pp. 66, 67, 104, 105, illus. A production control system used at the Pratt & Whitney Aircraft engine plant which provides continual visual indication of work progress.

Propellers

Pressure Welding Propeller Barrels. G. W. Motherwell, A. L. Rustay, S. M. Jablonski, and C. J. Burch. *Welding Journal*, Vol. 26, No. 11, November, 1947, pp. 994–1001, illus. 9 references.

A modification of the closed-joint method employing a multiple pressure cycle was used in the manufacture of propeller barrels from S.A.E. 4345 steel forgings. Tensile and yield strengths were obtained throughout the weld equivalent to those of the remainder of the barrel. Intimate contact of the abutting surfaces was maintained throughout the operation by providing a clean, flat, and smooth surface grind; by relieving the holding dies to support

the ends of the arms only; by coining the arms as a final forging operation; and by using a high initial pressure for welding. Stress relief treatment was required immediately after welding. The weld upset had to be removed prior to heat-treatment to prevent propagation of quench cracks from notches at the upsets.

Arc Welded Propeller Hub Weighs and Costs Less. *Automotive Industries*, Vol. 97, No. 10, November 15, 1947, p. 42, illus. Description of the arc-welded design of the Aeromatic propeller hubs F-200 and F-220.

Effect of Tilt of the Propeller Axis on the Longitudinal-Stability Characteristics of Single-Engine Airplanes. Harry J. Goett and Noel K. Delany. *U.S., N.A.C.A., Advance Confidential Report No. 4E29 (Wartime Report No. A-59)*, November, 1944. 71 pp., illus. 7 references.

Reverse Pitch Props. *Naval Aviation News*, No. 276, November, 1947, p. 18, illus. Account of tests to develop techniques that will permit seaplanes to use propeller reversal when landing but will avoid obscuring the pilot's vision by spray.

Engines and Reverse Pitch Propeller. *Plane Facts*, Vol. 6, No. 4, October, 1947, pp. 18, 19.

Propellers Are Not Expendable. Gilbert C. Close. *Western Flying*, Vol. 27, No. 11, November, 1947, pp. 12, 13, 24, illus.

An outline of propeller inspection, maintenance, and repair, with attention to the indications of moisture absorption; methods of checking for bent, warped, or improperly mounted propellers. Seven of the more serious propeller faults are listed.

Better Propellers for Light Pocketbooks. John F. Haines. *SAE Quarterly Transactions*, Vol. 1, No. 4, October, 1947, pp. 617–625, diagrs. (Cf. AER 6/47:53.)

Is the Propeller Here to Stay? Carl F. Baker. *The Pegasus*, Vol. 10, No. 5, November, 1947, pp. 8–12, illus.

German Wind Turbine Projects Planned During the Hitler Era. H. W. Hamm. *U.S., Field Information Agency, Technical, Final Report No. 1111*, May 13, 1947. 21 pp., illus. 12 references. New York, British Information Services. $1.00.

Electric Motor Test of Two Erco Compreg Blades, AAF Design No. 42K13717, With Cracks in Shank Sections, Installed in Hamilton Standard Hub, Design No. 2D30-227, for Use With an R-985-AN-1 Engine. R. L. Boyer. (Whirl Test No. 1906.) *U.S., Army Air Forces, Technical Report No. 5554*, February 18, 1947. 7 pp., illus.

Type Test of A.O.Smith Hollow Steel Blades Design No. SPA-11X in a Four Way Aeroproducts Hub Model No. A642-X23 for Use on the Pratt and Whitney R-2800-34W Engine as Installed in the A-26 and F-3M Airplanes. D. F. Hild. (Whirl Test No. 2045.) *U.S., Army Air Forces, Technical Report No. 5556*, February 24, 1947. 56 pp., illus. 5 references.

Electric Motor Calibration of Three 4-Blade Hamilton Standard Hydromatic Propellers for Use with R-2800-57 Engine on P-47M Airplane. L. H. Corsaw. (Whirl Test No. 2131.) *U.S., Army Air Forces, Technical Report No. 5555*, February 24, 1947. 22 pp., illus.

Engine Test on the Thomson Industries Constant Speed Propeller for Use on the O-435 Engine. E. A. Vonderheid. (Whirl Test No. 2089.) *U.S., Army Air Forces, Technical Report No. 5557*, February 26, 1947. 8 pp., illus.

Type Test of the Annesly Model 185 Propeller for Use on the L-5 Airplane. E. A. Vonderheid. (Whirl Test No. 1957.) *U.S., Army Air Forces, Technical Report No. 5558*, February 27, 1947. 7 pp., illus.

Engine Test of a Modified North American P-51B Spinner, Drawing No. 104-44002-10, Assembled on a Hamilton Standard 11 Ft. Diameter 24D50-J6523A-24 Propeller on a V-1650-3 Engine. L. H. Corsaw. (Whirl Test No. 1870.) *U.S., Army Air Forces, Technical Report No. 5558*, February 27, 1947. 7 pp., illus.

Reference & Bibliography

Reports and Memoranda (Nos. 2051–2150) Published Between 1st July, 1946 and 31st December, 1946. *Gt. Brit., Aeronautical Research Council, Reports and Memoranda No. 2150*, December, 1946. 6 pp. British Information Services, New York. $0.40.

The ZWB Classification and Its Relation to German Aeronautical Activities. G. Strohmeier. *U.S., Air Force, Memorandum Report No. F-MR-1-RE*, November, 1947. 7 pp., diagrs.

The ZWB (Scientific Information Center for Aeronautical Research) was a German governmental agency set up to collect, classify, and disseminate current technical literature on aeronautics and related fields to the industry and to scientific and military agencies. The classification scheme under which this information was filed divided the field into broad concepts and brought together those items of information which by their nature, or according to common practice, are grouped together. A supplementary topical or subject heading index, which was arranged alphabetically, made it possible to locate individual terms or applications on concepts within the scheme. A specialist selected the pertinent information for each of the agencies being served. The system did not depend on the functioning of a minute classification system but relied on the skill and experience of key personnel.

Rotating Wing Aircraft

Remarks on the Comparative Use of Reciprocating and Thermo-Propulsive Engines in Helicopters Flying at High Altitudes. R. Dorand. (*Congrès National de L'Aviation Française, 3ème, Paris, April 1–5, 1947, Report No. 4-108.*) *Cornell Aeronautical Laboratory, Translation*, October, 1947. 12 pp.

An analysis of the predicted performance of rotating-wing aircraft in which the rotors are driven by blade-tip jets utilizing a mixture of air and the products of combustion of a compressor unit. If the compressors, which also act as gas generators, allow the gas to be bled at various stages of compression or expansion, the jet temperature and pressure can be varied so as to provide good climbing and high-speed performance at high altitudes.

Possibilities of Reaction Propulsion Applied to Helicopters. André Bruel. (*Congrès National de L'Aviation Française, 3ème, Paris, April 1–5, 1947, Report No. 4-55.*) *Cornell Aeronautical Laboratory, Translation*, November, 1947. 15 pp., figs.

An analysis of the weights of engine-rotor groups, including the weight of the rotor, the hub, the engine or reactors, and the additional weight required by these systems. The present mechanical helicopter is lighter than a helicopter with a reactor at the blade tip for a flight of more than two hours. For flights of about an hour's duration the reactor power plant would be lighter. The required peripheral rotor velocities of from 150 to 160 m. per sec. are currently achievable.

Practical Stability and Controllability of Rotary-Wing Aircraft While Hovering. André Bruel. (*Congrès National de L'Aviation Française, 3ème, Paris, April 1–5, 1947, Report No. 4-54.*) *Cornell Aeronautical Laboratory, Translation*, October, 1947. 9 pp.

A nonmathematical discussion. Instability in hovering can be surpressed by automatic pilot systems or improved with respect to ease of piloting by increasing the period of oscillation of the machine. In conditions of stability, maneuverability during hovering is satisfactory. Under conditions of instability, a device should be provided to decrease the control effectiveness in order to compensate for the lack of damping. The stabilizer bar of the Bell-47 helicopter is an example of the use of an automatic piloting device in its simplest form.

Control, in Stationary Flight, of Large Helicopters with a Single Rotor or with Coaxial Rotors. M. Dorand. (*Congrès National de L'Aviation Française, 3ème, Paris, April 1–5, 1947, Sub-Section 31, Report No. 145.*) *Cornell Aeronautical Laboratory, Translation*, October, 1947. 9 pp.

An increase in the dimensions of a rotary-wing aircraft results in a large increase in the moment of inertia about the pitching and rolling axes compared with the small increase in the control effectiveness and in the damping couples for pitching and rolling oscillations. However, it is possible to make a large machine with a single rotor or with coaxial rotors which is just as maneuverable as a small machine by restraining the vertical deflections of the articulated blades. The deflections should be accompanied by variations in angle of attack which would amplify the control action in the correct sense at all flight speeds. The centrifugal forces that arise in changing the angle of attack of the machine create a damping couple exactly opposite to the motions of the machine.

Static-Thrust Investigation of Full-Scale PV-2 Helicopter Rotors Having NACA 0012.6 and 23012.6 Airfoil Sections. Stanley Lipson. *U.S., N.A.C.A., Memorandum Report No. L6D24 (Wartime Report No. L-749)*, May, 1946. 14 pp., illus. 2 references.

A New Configuration. *Aero Digest*, Vol. 55, No. 5, November, 1947, p. 51, illus.

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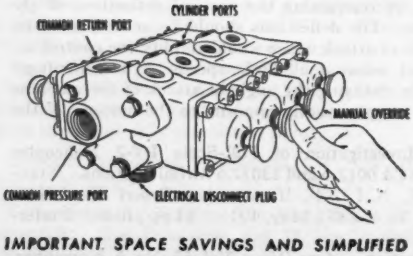

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A helicopter design suggested by M. F. Bates. The blades are to be attached to a ring that encircles a blister-type cabin. Since the center of gravity of such a helicopter configuration would be but slightly below the plane of rotation of the rotor blades, pendulation of the fuselage would be minimized.

The Bristol Type 171 (Coaxial-Rotor Helicopter). *The Aeroplane*, Vol. 73, No. 1899, October 31, 1947, pp. 583–587, illus. Includes cutaway drawings of the entire aircraft, and rotor hub and control mechanisms.

Aeroplanes in Detail. LXXIII—The Bristol Type 171 Helicopter. *The Aeroplane Spotter*, Vol. 8, No. 199, p. 250, cutaway diagr.

Design Features of Flettner 282 Helicopter. J. C. Siltanen. *Plane Facts*, Vol. 4, No. 3, August, 1947, pp. 4–6, 24, illus.

Motorcycle of the Sky (Hoppi-Copter Model 102). Barkley K. Barclay. *American Helicopter*, Vol. 8, No. 12, November, 1947, pp. 18, 19, 27, 28, illus.

Movable Cabin Controls (Seibel) Helicopter; By Shifting C.G. in Flight, a Simpler Rotor Assembly Is Possible. *Aviation Week*; Vol. 47, No. 18, November 3, 1947, pp. 22, 25, 27, illus. (Cf. AER 1/48:57.)

Rotor Head by United. *Aero Digest*, Vol. 55, No. 5, November, 1947, p. 51, diagr.

United Helicopters, Inc., have adapted the autogiro direct control system to the helicopter. The rotor head to which the blades are rigidly attached is universally mounted on the axis of rotation. A mechanical linkage permits the axis of rotation to be tilted. Dynamic inertia prevents the blade unit from following the tilted axis and flapping ensues relative to the axis. This action is the equivalent of cyclic feathering.

U.S. Coast Guard Develops Instrument Flight. F. A. Erickson. *American Helicopter*, Vol. 8, No. 12, November, 1947, pp. 8, 9, 25, 26, illus.

The Sperry Gyroscope Company, Inc., has loaned to the Coast Guard a directional gyroscope with a top reading face which has been mounted with the attitude gyroscope on the fore and aft line of a helicopter. The installation is a preliminary step in the development of a combined direction and attitude indicator.

Los Angeles Helicopter Airmail Inauguration. Fanchon Devoe. *American Helicopter*, Vol. 8, No. 12, November, 1947, pp. 6, 7, 24, illus.

Operations with the Fleet. J. W. Bunkley. *American Helicopter*, Vol. 8, No. 12, November, 1947, pp. 12, 13, illus.

Safety & Rescue

Prevention of Rocket Aircraft Fires. J. Naiman. *Plane Facts*, Vol. 6, No. 4, October, 1947, pp. 6, 7, illus.

The basic fire prevention criteria established by the Air Materiel Command and private organizations for the prevention of fires and explosions during the test-stand operation of reaction-type engines.

Aircraft Rescue and Fire Fighting. II. *Airports*, Vol. 12 No. 5, November, 1947, pp. 30, 31, 38, illus. (Cf. AER 1/48:57.)

Standard operating procedure adopted by the National Fire Protection Association. Action to be taken in land crashes off the airport, crashes on water, the policy of cooperation with local public fire departments, and aircraft crew training and discipline are outlined. Appendixes include minimum standards for aircraft rescue.

Operation Splash. Gene Whittington. *Boeing Magazine*, Vol. 17, No. 11, November, 1947, pp. 10, 11, illus. General procedure of a B-17 ditching test.

Sciences, General

MATHEMATICS

Some Improvements in the Use of Relaxation Methods for the Solution of Ordinary and Partial Differential Equations. L. Fox. *Royal Society of London, Proceedings, Series A*, Vol. 190, No. 1020, June 17, 1947, pp. 31–59, figs. 12 references.

In the solution by numerical methods of ordinary and partial differential equations, the derivatives are replaced by their finite-difference equivalents, usually infinite series of differences. For the employment of relaxation methods it has been customary to ignore all but the dominant first term of these series, taking sufficient intervals to ensure the effective vanishing of the neglected terms. In the methods developed the full difference equations can be used at the maximum interval consistent with the convergence of the differences. The number of mesh points, and hence the labor and difficulty of the relaxation process, is thus considerably reduced, and increased accuracy is obtained. The method is applied to eight examples, including ordinary and partial differential equations, eigen-value problems, and the more difficult problem of curved boundaries.

Solution of Equations Simplified. Albert S. Goodrich, Jr. *Machine Design*, Vol. 19, No. 11, November, 1947, pp. 141, 142, 182, 184, charts. 3 references.

An exposition of Graeffe's root-squaring method by which the real and complex roots of high-degree algebraic equations may be solved to any degree of accuracy. Three specimen equations are worked out in full.

A Resistor Network for the Approximate Solution of the Laplace Equation. David C. dePackh. *Review of Scientific Instruments*, Vol. 18, No. 10, October, 1947, pp. 798, 799, figs. 1 reference.

Seaplanes & Flying Boats

Tank Tests of a Powered Dynamic Model of a Flying Boat Having an Afterbody Length-Beam Ratio of 4.7, Langley Tank Model 203C-1. Roland E. Olson and Marvin I. Haar. *U.S., N.A.C.A., Memorandum Report No. L5128* (*Wartime Report No. L-762*), October, 1945. 19 pp., figs. 4 references.

Spray Characteristics and Take-Off and Landing Stability of Several Modifications of a 1/9-Size Model of the PBN- Flying Boat—NACA Model 192. David R. Woodward and Howard Zeck. *U.S., N.A.C.A., Memorandum Report No. L5C30* (*Wartime Report No. L-567*), April, 1945. 52 pp., illus. 2 references.

New Seaplane Hull to Make Better Speeds. *Naval Aviation News*, No. 276, November, 1947, p. 13, illus. A description of three experimental hulls to be tested by the N.A.C.A. in cooperation with the Naval Air Test Center. Hulls are to be tested on a modified Grumman J4F Widgeon.

NACA Hydro-Flap Adapted to Navy Planes (To Improve Ditching Characteristics). *Naval Aviation News*, No. 276, November, 1947, p. 27, illus.

Ditching Behavior of Military Airplanes as Affected by Ditching Aids. Margaret F. Steiner. *U.S., N.A.C.A., Memorandum Report No. L5A16* (*Wartime Report L-647*), January, 1945, 29 pp., illus. 3 references.

Standards & Specifications

Engineering and Manufacturing Standards. W. L. Matthew. *Product Engineering*, Vol. 18, No. 11, November, 1947, pp. 81–86, illus.

Formation and maintenance of an engineering standards system at the Caterpillar Tractor Company, origin and preparation of new standards, and sample standard pages and forms used in the administration of the system.

Stress Analysis & Structures

Stress Concentration Due to Four-Point Fixing at Front End of Monocoque Fuselage, Theoretical Analysis. M. Fine and D. Williams. *Gt. Brit., Aeronautical Research Council, Reports and Memoranda No. 2100*, April, 1941. 28 pp., figs. British Information Services, New York. $1.50.

From working out typical cases it is inferred that for the end-to-end constant-section longerons the disturbance due to the four-point fixing does not extend a greater distance from the root fixing than 1/2 to 3/4 of the average root diameter, this distance being greater the greater the value of the ratio of total stringer area to total skin area in the cross section. The constant-stress longeron tapers quickly and appears to offer a good practical basis for design. The most important stress concentration in both cases is the shear stress in the skin immediately adjacent to the longerons at their root ends, and reinforcement of the skin thickness in this region is probably essential in all practical cases, especially for the constant-stress longeron. The extent of this stress concentration is indicated by certain contour diagrams of stress distribution.

Empirical Formulas for the Fundamental Natural Bending Frequencies of Cantilever Duraluminum Wings. Ben Smilg. *U.S., Army Air Forces, Technical Report 4525, Revision 1*, January 29, 1947. 11 pp., fig. 5 references.

The data that have been obtained on the fundamental bending frequency of the semispan of an aircraft wing fits reasonably well into a simple formula in which the semispan is the only parameter. Tests were conducted on many types of aircraft with differing wing construction and configuration, and the formula was found to be as accurate as more laborious and elaborate methods of computing the natural frequency.

The Effect of an Outboard Engine on the Flutter Characteristics of a Wing (Investigated with Examples). H. Wittmeyer. (*Lilienthal-Gesellschaft, Bericht No. 135*, March, 1941, pp. 94–107. *Cornell Aeronautical Laboratory, Translation*, September, 1947. 34 pp., diagrs. 8 references.

The effect of torsional stiffness of the internal wing structure, the position of the engine center of gravity and the softness of the engine suspension were investigated for a wing with an outboard engine. An important result is that it is not always permissable to regard the wing, in flutter calculations, as being restrained at the outboard engine.

A Simplified Method for the Design of Vibration-Isolating Suspensions. R. C. Lewis and Karl Unholtz. *American Society of Mechanical Engineers, Transactions*, Vol. 69, No. 8, November, 1947, pp. 813–819, diagrs. 6 references.

A new type of chart and design method for dealing with the coupled natural frequencies of suspended bodies. This simplification of the chart method of design resulted from a regrouping of the variables of the equations of motion. Some of the confusing multiplicity of choices open to the designer is resolved by the breeding of a new family of vibration isolators that have orderly characteristics, thus reducing some of the variables to controlled parameters. These simplifications result in a design method that uses synthesis rather than the cut-and-try method of analysis. The chart is in effect a space plot upon which the actual outline of the body to be isolated can be projected. The mount points for a simple suspension of the object can be spotted on the chart and the complete dynamic solution of the suspension can be read directly. The mounting points providing the best frequency spectrum are immediately obvious.

Bending Rigidity and Column Strength of Thin Sections. P. E. Sandorff. *American Society of Mechanical Engineers, Transactions*, Vol. 69, No. 8, November, 1947, pp. 833–841, diagrs. 11 references.

Elementary structural theory cannot be applied with accuracy to problems concerning beams and columns having thin deep webs and thin wide flanges, because of nonuniform stress distribution that exists in the flanges. The problems of nonuniform axial flange stress are treated here by means of efficiency factors that apply to the flange material. These basic factors are evaluated from theoretical considerations. Then, given a particular section and the manner of loading, it is necessary only to apply the proper flange efficiency factor to calculate reduced or effective section properties, which can be used in place of the geometrical properties in the elementary formulas for lateral bending or lateral column buckling. Empirical data confirm the results. Examples illustrate practical usage. The tangent-modulus column curve is shown to apply to stiffened-skin panels when based on a "true slenderness ratio" that allows for shear lag effects.

Prediction and Reduction to Minimum Properties of Plate Compressive Curves. E. H. Schuette and J. C. McDonald. *Journal of the Aeronautical Sciences*, Vol. 15, No. 1, January, 1948, pp. 23–27, 48, figs. 8 references. (*See* AER 7/47:29.)

Mixed Boundary Conditions in the Relaxation Treatment of Biharmonic Problems (Plane Strain or Stress). L. Fox. *Royal Society of London, Proceedings, Series A*, Vol. 189, No. 1019, June 3, 1947, pp. 535–543, figs. 2 references.

Relaxation methods have already been applied to the solution of four problems of extension and flexure of flat elastic plates, in which displacement or traction is specified at the boundary. Here the method is adapted to the case in which the two types of boundary conditions are mixed, where photoelastic methods are difficult to apply. Two examples are treated by relaxation methods, and the results obtained indicate that this method may be a valuable alternative in engineering problems.

The Buckling of a Flat Rectangular Plate Under Axial Compression and Its Behavior After Buckling. II—Conditions for Permanent Buckles. H. L. Cox. *Gt. Brit., Aeronautical Research Council, Reports and Memoranda No. 2175*, October, 1945. 8 pp., figs. 1 reference. British Information Services, New York. $0.60. (Cf. AER 4/47:68.)

The formulas for the distribution of stress in terms of the wave length of the buckle and the degree of lateral restraint which are developed in the first part of the report are so complex that the problem must be simplified by considering only the case in which the edges of the plate are kept straight but no lateral restraint is imposed. This case is considered because probably the post-buckling stresses are more closely associated with the postbuckling stiffness than with the buckling stresses. The complexity

that is introduced by using the von Mises criterion or the maximum shear stress as a criterion of elastic failure is so great that a further simplification is made by considering the mean stress through the plate thickness to "follow" the stress at the surface; that is, the local maximum shear stress. Nominal maximum stresses in a buckled plate are tabulated, and an empirical method is used to apply them to a panel stiffened by two stringers.

Stability of Plates and Shells Beyond the Proportional Limit. A. A. Iliushin. (*Prikladnaia Matematika i Mekhanika* (Moscow), Vol. 8, No. 5, 1944, pp. 337–360), *U.S., N.A.C.A., Technical Memorandum No. 1116*, October, 1947. 44 pp., tables. 16 references.

Relations between plane stress and strain in the plastic region are assumed; these relations make use of the stress-strain curve for the material. Small variations in stress due to small variations in strain are computed, and the results are then applied to problems in the stability of rectangular plates and cylindrical shells beyond the elastic range.

Determination of Plate Compressive Strengths. George J. Heimerl. *U.S., N.A.C.A., Technical Note No. 1480*, December, 1947. 19 pp., illus. 12 references.

Results are summarized of local-instability tests of H-, Z-, and C-section plate assemblies for four extruded aluminum alloys and two magnesium alloys. Methods are suggested for determining the critical compressive stress and the average stress at maximum load for flat plates by the use of the compressive stress-strain curve for the material.

Buckling of Curved Sheet in Compression and Its Relation to the Secant Modulus. E. H. Schuette. *Journal of the Aeronautical Sciences*, Vol. 15, No. 1, January, 1948, pp. 18–22, diagrs. 1 reference. (*See* AER 7/47:28.)

Data on Buckling Strength of Curved Sheet in Compression. Harold Crate and L. Ross Levin. *U.S., N.A.C.A., Advance Restricted Report No. 3J04* (*Wartime Report No. L-557*), October, 1943. 13 pp., diagrs. 5 references.

Elementary Shear Flow Analysis. T. R. Loudon. *Engineering Journal*, Vol. 30, No. 9, September, 1947, pp. 414–420, 433, diagrs. 5 references.

A résumé of methods for reasonably accurate determination of shear flow in stringer skin combinations commonly found in aircraft construction. Formulas are derived for the shear flow due to bending, the resultant total shears in a curved sheet between two points, and for the torsional deformation of the cylinders. Problems are worked out to illustrate the calculation of shear flows due to bending and torsion in open and closed sections and in multicell structures and in tapered webs. The buckling effect in web panels under design loads is not taken into account, and the determination of effective sections with modified neutral axes is not discussed.

A Method of Calculating the Compressive Strength of Z-Stiffened Panels That Develop Local Instability. George L. Gallaher and Rolla B. Boughan. *U.S., N.A.C.A., Technical Note No. 1482*, November 1947. 15 pp., figs. 7 references.

The method is based on the elastic theory for plate buckling and test results for 24S-T aluminum-alloy Z-stiffened panels. It can be used to calculate the critical compressive stress above and within the elastic range. For stresses above three-fourths the compressive yield stress, the method can be used for the approximate determination of the average compressive stress at maximum load.

The Theory of Combined Plastic and Elastic Deformation With Particular Reference to a Thick Tube Under Internal Pressure. R. Hill, E. H. Lees, and S. J. Tupper. *Royal Society of London, Proceedings, Series A*, Vol. 191, No. 1026, November 18, 1947, pp. 278–303, figs. 7 references.

In certain problems of plastic flow (for example, a thick tube expanded by internal pressure), it is important to consider changes in the elastic strain of material that is flowing plastically in order to deduce the correct stress distribution and deformation. The usual plastic theory, which neglects elastic strains in the plastic region, may lead to considerable errors in certain cases. The theory of the deformation of a material under combined stresses which involves both elastic and plastic components of strain is reviewed. The relationship between stress and strain is represented on a plane diagram, the reduced stress-strain diagram, which facilitates discrimination between the elastic and plastic components of strain and aids considerably the solution of certain problems. The diagram can also be used to express the relationships governing the dissipation of energy during plastic flow under combined stresses. The theory is applied to the deformation of a long thick tube under internal pressure with zero longitudinal extension. The solution is compared with that based on the usual theory that neglects elastic strains in the plastic region, revealing an error that reaches a maximum of over 60 per cent in the longitudinal stress distribution. The significance of the differences between the two solutions is discussed in detail.

Some Investigations of the General Instability of Stiffened Metal Cylinders. IX—Criterions for the Design of Stiffened Metal Cylinders Subject to General Instability Failures. Louis G. Dunn. *U.S., N.A.C.A., Technical Note No. 1198*, November, 1947. 49 pp., illus. 15 references.

Results of an experimental investigation of the general instability of reinforced thin-walled metal cylinders subjected to pure bending and pure torsion over a range of geometrical quantities and structural sectional characteristics. Based on the experimental results and an existing theory of unstiffened metal cylinders, parameters were evolved which make possible an estimate of the stress at which general instability will occur for any given stiffened metal structure of circular cross section.

Diagonal Tension in Curved Webs. Paul Kuhn and George E. Griffith. *U.S., N.A.C.A., Technical Note No. 1481*, November, 1947. 29 pp., diagrs. 10 references.

The engineering theory of incomplete diagonal tension in plane webs presented in N.A.C.A. Technical Note No. 1364 is generalized in order to make it applicable to curved webs. Calculated and experimental results are compared for a number of stiffened cylinders subjected to torsional loads. The results indicate that the theory predicts the stresses to about the same accuracy for curved webs as for plane webs. The failing stresses in the stringers in curved webs were predicted conservatively in all cases.

Optimum Number of Webs Required for a Multicell Box Under Bending. George Gerard. *Journal of the Aeronautical Sciences*, Vol. 15, No. 1, January, 1948, pp. 53–56, diagrs. 1 reference. (*See* AER 8/47:31.)

Spot-Welded Aluminum Lap Joints Designed for Repeated Loads. Robert C. McMaster and Horace J. Grover. *Product Engineering*, Vol. 18, No. 11, November, 1947, pp. 112–116, illus.

A series of fatigue tests of spot-welded lap joints of 24S-T Alclad indicated that their strength under repeated tension loading does not increase in the same proportion as their static strength when spot size, sheet thickness, spot spacing, and pattern were varied. Long life fatigue failures occurred by cracking of the sheet around the spot welds, while static failures occurred by shearing through the weld nugget. For high-stress repeated loading there appeared to be no advantage in restricting the nugget diameter or the static shear strength to low values. The Alclad bonding may contribute to the fatigue strength of the spot welds, as well as to the static shear strength.

The Statistical Estimation of the Effect of Size on the Breaking Stress of Rods. C. Gurney. *Gt. Brit., Aeronautical Research Council, Reports and Memoranda No. 2157*, March, 1945. 10 pp., figs. 11 references. British Information Services, New York. $0.60.

An appreciable size effect on strength is to be expected in materials with large variation in the strength of nominally identical test pieces. Methods of estimating the size effect from the scatter of test results are described, and it is shown that some thousands of test results are necessary to obtain a reasonable estimate of the strength of material whose size differs much from that tested. The theory strictly applies only to material that is statistically homogeneous, which many practically useful materials are not. For such materials the theory can be expected to give only qualitative results; the predicted strength-size gradient is usually greater than that obtained experimentally. There is a need for test results on different sizes of material so that the accuracy of the predictions of the theory can be assessed.

Investigation of the Strength of Bronze Welded Joints. M. S. Fisher. *Institute of Welding, Transactions*, Vol. 10, No. 5, October, 1947, pp. 149–160, illus.

Bronze welded joints in various types of steel have been tested mechanically and examined microscopically. Suitable types of bronze welded joints have about the same static strength as similar oxy-acetylene fusion welds but are not quite so strong as arc welds. Steels requiring heat-treatment after welding should not be bronze welded. Under certain conditions intercrystalline cracking of the parent metal may occur during bronze welding, especially in stainless steel.

Thermodynamics

The Detonation Process in Gases. W. Döring. (*Annalen der Physik*, 5th Series, Vol. 43, No. 6–7, pp. 421–436, 1943.) *Cornell Aeronautical Laboratory, Translation*, September, 1947. 14 pp., figs. 14 references.

A theory of detonation is developed from consideration of an idealized two-dimensional detonation wave that probably represents gas mixtures having slow reaction velocities. The detonation wave is assumed to be a shock wave that removes the resistance to chemical reaction by increasing the temperature and pressure of the mixture, and thus permits the reaction to proceed behind it unhindered. In the transformation zone behind the shock wave the laws of continuum physics are applied, with friction and heat-transfer being neglected. The laws of the general theory of detonation are fulfilled by this concept, but the thermodynamic properties that correspond to the points of the Hugoniot curve below the point with the least—i.e., normal—detonation velocity cannot occur in the combusted gases behind a two-dimensional detonation wave. This is because of the impossibility of having a stationary expansion shock present in the transformation zone or behind it. Even if the reaction velocity is extremely slow, a two-dimensional detonation wave will set up the normal detonation velocity. When the reaction velocity is extremely slow, the effect of the wall can cause a stationary, but not strictly two-dimensional, detonation wave having a smaller detonation velocity than normal. If the reaction velocity is sufficiently slow, the wave can be continuously weakened until it becomes a sound wave. The magnitude of this decrease and the position of the detonation limit apparently depend on the reaction time multiplied by the detonation velocity and divided by the tube diameter.

Heat Transfer to Molten Metals. R. C. Martinelli. *American Society of Mechanical Engineers, Transactions*, Vol. 69, No. 8, November, 1947, pp. 947–959, figs. 20 references.

The paper is based on an extension of the analogy between heat and momentum transfer. Following the suggestion of von Kármán, the turbulent-flow field is divided into a laminar sublayer, a buffer layer, and a turbulent core. The thermal resistances of the laminar sublayer and the buffer layer are calculated as by Boelter, Martinelli, and Jonassen, but the thermal resistance of the turbulent core is re-evaluated for very low values of the Prandtl modulus (molten metals) by considering the simultaneous transfer of heat by molecular conduction and eddy diffusion. The relative importance of the thermal resistances of the laminar sublayer, buffer layer, and turbulent core is discussed, and the temperature distribution in the fluid is evaluated for various magnitudes of the Prandtl modulus. It is demonstrated that the unit conductance for convective heat transfer is proportional to the square root, rather than the first power, of the friction factor. A tentative analysis is made of the data of Cope for heat transfer in rough pipes.

Heat Transfer at Low Temperatures Between Tube Walls and Gases in Turbulent Flow. T. A. Hall. *Royal Society of London, Proceedings, Series A*, Vol. 191, No. 1024, September 26, 1947, pp. 6–21, 1 p. plates. 16 references.

An apparatus was designed on the counter-flow system to study heat transfer between tube walls and gases at low temperatures in a region in which careful measurements had not previously been made. Oxygen, nitrogen, and carbon dioxide were used, covering a temperature range from +45° to −167°C., pressures up to 11 atmospheres, and Reynolds Numbers from 3,000 to 60,000. Results were correlated by the use of dimensionless groups, and a general equation was obtained, independent of the nature of the gas and applicable over the whole range of experiments. With Reynolds Numbers evaluated at mean film temperatures, the coefficient in the equation was found to be 5 per cent lower than that obtained from measurements made at normal and high temperatures. This is regarded as justifying the extension of the ordinary equation to low-temperature regions. Determinations on friction accompanying heat transfer with gases in turbulent flow at low temperatures showed that the effect of heat transfer on the friction factor was small.

Wind Tunnels & Laboratories

Note on the Application of the Linear Perturbation Theory to Determine the Effect of Compressibility on the Wind Tunnel Constraint on a Propeller. A. D. Young. *Gt. Brit., Aeronautical Research Council, Reports and Memoranda No. 2113*, November, 1944. 6 pp. 3 references. British Information Services, New York. $0.40.

Both in compressible and incompressible flow the pressure function behaves as a potential function, if the assumptions of the linear perturbation theory are accepted. The form of the differential equation satisfied by the pressure function in compressible flow is such that a complete correlation is readily established between the pressure field about a propeller giving a certain pressure rise in compressible flow and that about the same propeller giving the same pressure rise in incompressible flow. This fact is applied to determine the effect of compressibility on the constant acting of a propeller in a wind tunnel. The correction factor to the tunnel velocity to give the equivalent air velocity, corresponding to the same pressure rise across the disc and rate of rotation, is unaffected by compressibility. If it is assumed that changes across the propeller disc are adiabatic, the correction in terms of thrust coefficient is the same as that in incompressible flow for the thrust coefficient multiplied by $1/(1 - M^2)$.

A Method of Wind-Tunnel Testing Through the Transonic Range. John H. Weaver. *Journal of the Aeronautical Sciences*, Vol. 15, No. 1, January, 1948, pp. 28–34, illus. 3 references. (*See* AER 9/47:29.)

Wall Interference in a Two-Dimensional-Flow Wind Tunnel with Consideration of the Effect of Compressibility. H. Julian Allen and Walter G. Vincenti. *U.S., N.A.C.A., Advance Restricted Report No. 4K03* (*Wartime Report No. A-63*), December, 1944. 96 pp., figs. 18 references.

High-Altitude Flight. *De Havilland Gazette*, No. 41, October, 1947, pp. 8–10, illus.

A description of the de Havilland high-altitude test installation. The main chamber is 14 ft. in diameter and 35 ft. long and can simulate pressure conditions of 70,000-ft. altitude. The temperature of the chamber can be varied between +40° and −70°C. Provision is made for testing fuel and electrical systems and other accessory equipment. Specifications are given for the refrigeration and decompression equipment.

A New Wind Tunnel (Royal Aircraft Establishment). *Newnes Practical Mechanics*, Vol. 14, No. 167, September, 1947, p. 370, diagrs.

Testing at Supersonic Speeds. *Western Flying*, Vol. 27, No. 11, November, 1947, p. 22, illus.

The Aerophysics Laboratory of North American Aviation, Inc., is operating a supersonic wind tunnel that has an operating range of from 1.25–3.25 Mach. This continuous-flow tunnel has a test section 1.75 by 4.5 in. and incorporates an adjustable diffuser in the exhaust section which makes possible the maximum air speed for the pressure being used. A towing basin is also being used to study supersonic flow. Air speeds as high as 7,000 m.p.h. can be simulated. While the data obtained is not as accurate as that of wind-tunnel tests, it is useful for qualitative studies.

Wind-Tunnel Heat Leakage Decreased Ninety Percent by Insulation. *Engineering News-Record*, Vol. 139, No. 18, October 30, 1947, p. 68, illus.

The altitude wind tunnel of the Aircraft Engine Research Laboratories of the N.A.C.A. has a test area 20 ft. in diameter. The largest aircraft power plants now in existence can be tested at −45°F. and at pressures equivalent to an altitude of 50,000 ft. Description of the double wall construction and mineral wool insulation.

University of Maryland Wind Tunnel Ready for Use in Early Part of '48. *The Martin Star*, Vol. 6, No. 10, November, 1947, pp. 6, 7, 15, illus., diagr.

The return-flow wind tunnel to be operated by the Glenn L. Martin College of Engineering and Aeronautical Sciences at the University of Maryland will have a test section 7 ft. 9 in. wide. Electric motors with a peak capacity of 2,250 hp. will drive a seven-bladed propeller and provide an air speed of 350 m.p.h.

When You Build a Wind Tunnel. *General Electric Company, Apparatus Department*, July, 1947. 23 pp., illus.

The characteristics of seven types of variable-speed electric motors with horse-power ratings between 200 and 20,000 are described in their application to the various types of wind tunnels. Custom built motors for test models have been provided which have speeds as high as 80,000 r.p.m. and deliver 0.1 hp. while the diameter remains as small as 1.75 in. Meters, recorders, light sources, and gages, and electronic amplifiers and differential analyzers which are used as measuring and testing equipment are also shown in their wind-tunnel application.

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	ROD AND BAR					
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Cu 29.0	Heat treated	140-160	100-120	30-20	265-300	40
Al 2.75	As Cold-drawn	100-135	70-100	35-13	175-260	56
Fe 0.9	Heat treated	140-170	100-130	30-15	265-320	26

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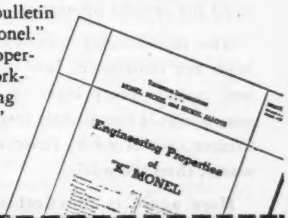

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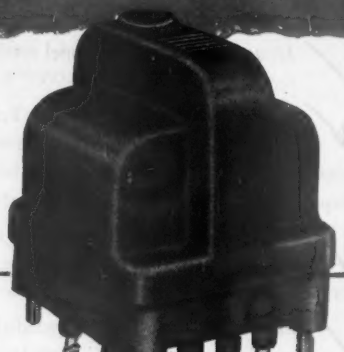
FROM arctic to tropic conditions within a matter of minutes is an everyday occurrence for many aircraft. Ordinarily, a result of such sharp, sudden changes would be rapid deterioration of the transformers in a plane's electronic equipment. But here, Honeywell Creative Engineering anticipated the need for special protection—and developed the answer.

The transformer housing of all-phenolic plastic combines light weight, high arc resistance, low moisture absorption and strength. A varnish-like seal guards every layer of insulation against break-down. And finally the entire unit is completely impregnated with a black wax. The result is a transformer unaffected by ten-cycle tests of half-hour immersions in first boiling water, then ice water.

Here again is practical evidence of Honeywell Creative Engineering at work. It accounts for the reason why all Honeywell aeronautical controls promote improved efficiency with minimum maintenance—and are recognized for their dependability. Minneapolis-Honeywell, Minneapolis 8, Minnesota. In Canada: Toronto 12, Ontario.



In a Laboratory "Jungle"...

Honeywell Creative Engineering developed this transformer housing that effectively resists dirt, dust infiltration and damaging moisture condensation.

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Books

An Introduction to Aerodynamic Compressibility. J. Black. London, Bunhill Publications, Ltd., 1947. 122 pp., illus., diagrs., figs. 18*s*.

The study of the flow of gases at high speed has assumed increased importance because of recent activities directed toward the development of high-speed aircraft, rocket projectiles, and gas turbines. Compressibility problems arise in the external flow of gases over the airplane and the internal flow of the working fluid through the compressors, turbines, and nozzles of jet engines. Problems of supersonic flow also are of fundamental importance to the ballistics physicist. While a considerable amount of work has been carried out on compressible flow, information about the results of this research has been scattered through many books, journals, and reports. This introduction to aerodynamic compressibility has been prepared to present in convenient form the most important theoretical and experimental results that have been obtained in the study of the subject. Practicing engineers who are forced to deal with compressibility problems for the first time because of recent design trends will find this volume of the greatest value. The book will enable the engineer actually engaged in compressibility flow problems to become fully acquainted with the existing knowledge of the subject. Engineering students will find the clear exposition helpful.

Chapters are devoted to general considerations of compressible flow, energy relations and the thermodynamics of flow, flow through nozzles and high-speed wind tunnels, the formation and propagation of shock waves, the theoretical analysis of flow past various bodies, and high-speed flight and the design aspects of compressibility. Information about optical systems for the photography of the high-speed flow of gases and a table of two-seventh powers for use in compressibility problems are included in the appendix. Excellent half-tone plates show how shock waves are produced by a 20-mm. cannon shell, the formation of shock waves on airfoils, the flow past an airfoil at increasing speed, and flow separation caused by the formation of a shock wave. There are over 50 footnote references to published papers and research reports.

For information on I.A.S. Library Service Facilities, see page 37

Modern Gas Turbines. Arthur W. Judge. London, Chapman and Hall, Ltd., 1947. 311 pp., illus, diagrs. 28*s*.

Written by an author who is well known for his many authoritative works on internal combustion engines, *Modern Gas Turbines* will be welcomed as a valuable contribution to the limited number of books on a type of power plant which, although of comparatively recent origin, is proving to have outstanding potentialities, especially for the propulsion of high-speed aircraft. In preparing this volume the author's purpose has been to present a clear and accurate outline of the theory and development of gas turbines which will form an introduction to more advanced considerations of the subject as discussed in various reference works and papers, many of which are listed in the bibliography at the end of the book. An examination of the text reveals that he has been entirely successful in accomplishing this objective.

Following an introductory review of the history of gas turbine development, consideration is given to some of the advantages and limitations of the gas turbine. The characteristics of this type of power plant are compared with those of the steam turbine and Diesel engine. Some preliminary information about the efficiencies of gas turbines and the results obtained from tests of gas turbine installations are given. While it is assumed that the reader is conversant with the general principles of thermodynamics of heat engines, a brief summary of the thermodynamics of the gas turbine is presented in Chapter 3. Chapter 4 explains how the efficiencies of gas turbines are estimated from a knowledge of their working cycles, temperatures, and pressures. Means of increasing the efficiency of the gas turbine are considered in Chapter 5,. while Chapter 6 is devoted to the closed-cycle gas turbine. Chapter 7 deals with exhaust gas turbines for supercharging engines. Of particular interest to aeronautical engineers is the extensive discussion of gas turbines for aircraft presented in Chapter 8. Chapter 9 discusses other applications. The final chapter is devoted to a study of materials for gas turbines. Appendixes contain notes on turbine blade design and blade-fixing methods. More than 200 illustrations are included in the volume.

Radar Aids to Navigation. Edited by John S. Hall. Office of Scientific Research and Development, National Defense Research Committee. (Massachusetts Institute of Technology, Radiation Laboratory Series, Vol. II.) New York, McGraw-Hill Book Co., Inc., 1947. 389 pp., illus., diagrs. $5.00.

This is the second volume of a series that is being prepared to reveal the many developments in radar and related techniques which have resulted from the intensive research work carried out during World War II. While the task of preparing these volumes was undertaken by the Radiation Laboratory of the Massachusetts Institute of Technology, which operated under the supervision of the National Defense Research Committee, the work described is the collective result of work done at many laboratories, Army, Navy, university, and industrial, both in the United States and in England, Canada, and other Dominions.

Volume II is devoted primarily to a description of the advantages and limitations of radar equipment when applied to problems of navigation and pilotage. It covers airborne, shipborne, and ground-based equipment, and emphasis is placed more on what can be done with radar rather than consideration of its future possibilities. The development of a number of nonradar navigational aids was accelerated during the time radar developments were proceeding. These including Loran, Gee, and certain azimuthal systems. To provide a more comprehensive picture of available techniques, descriptions of these and other nonradar aids are included. The book is divided into four parts, which includes an introductory section and sections on airborne radar, ground-based radar, and shipborne radar. Nontechnical readers will find chapters 2, 3, 8 and 9 most interesting. They discuss nonradar navigational methods, the characteristics of airborne radar, radar aids to air navigation and traffic control, and navigation and pilotage. Other chapters deal with technical aspects of the subject. Radar indicators are de-

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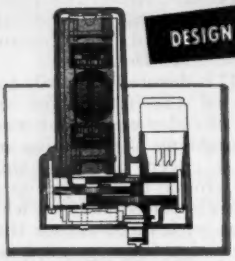

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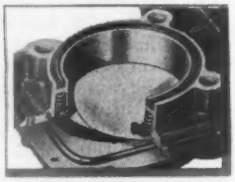

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scribed in considerable detail because these components are of great interest to the navigator. Particular attention is given to airborne radar used with beacons as an anticollision device on overwater flights because, it is stated, it does not appear reasonable to require that all airplanes flying over land have beacons. The volume contains many excellent illustrations and diagrams. The text is documented by some footnotes and lists of references.

Jigs and Fixtures for Mass Production. Leland A. Bryant and Thomas A. Dickinson. New York, Pitman Publishing Corp., 1947. 222 pp., illus., diagrs. $3.50.

Because those tools that are collectively known as jigs and fixtures are used in the manufacture of virtually all products, this book, which provides extensive and reliable information about such tools, will be welcomed by tool and mechanical engineers, shop superintendents, plant managers, manufacturing executives, and others connected with the manufacturing industry. Both authors have the background of experience necessary to the writing of an authoritative work on the subject. Leland A. Bryant is Chief Tool Engineer for the Aircraft Engineering Company. He has spent approximately 20 years as tooling engineer in various industries and is inventor of the master tooling dock. Thomas A. Dickson is a consulting engineer for the Calresin Corporation and is the author of several books. He has served as an aircraft inspector and as a technical writer for an aircraft company. He also has been a frequent contributor to publications in the aeronautical, machinery, and plastics fields. The book covers thoroughly the subjects of plastics, pneumatics, and hydraulics as applied to tooling and considers the important wartime developments in the field of industrial tooling. Several characteristics of the text are outstanding. It is simply written and well illustrated so that it can be understood by the plant manager or executive concerned with functional problems, as well as by the trained and experienced tool engineer. Unlike other books on jigs and fixtures, it traces the history of the subject and shows how it is related to industry as a whole, not just to the machine shop.

There is a full discussion of the design and construction of jigs and fixtures and of the various types of tooling procedures. Particular attention is given to assembly tooling on which large-scale production depends so much.

The discussions are confined to those types of tooling principles and methods which have been tried and found satisfactory. To make sure the various terms used will be fully understood, the text is supplemented by a complete glossary. An appendix contains a list of tool symbols and other useful data. Chapters discuss the need for jigs and fixtures, tooling pro-

cedures, designing jigs and fixtures, master tools, the master tooling dock, the construction of jigs and fixtures, pneumatic and hydraulic mechanisms, plastics, and miscellaneous jigs and fixtures.

Other Books Received

AIR TRANSPORT

Air-Line Distances Between Cities in the United States. C. A. Whitten. (U.S., Coast and Geodetic Survey, Special Publication No. 238.) U.S. Govt. Printing Office, Washington, 1947. 246 pp. $1.75. The selection of cities is based on a list of authorized points on certificated routes of all domestic air carriers. The basic list contains 392 cities. To meet anticipated needs, 100 additional cities are included.

Air Transport Agreement Between the Government of the United Kingdom of Great Britain and Northern Ireland and the Government of the Republic of China (with Exchange of Notes), Nanking, 23rd July, 1947. (Treaty Series No. 71 (1947)). (Cmd 7211.) London, H.M. Stationery Office; New York, British Information Services, 1947. 37 pp. $0.25.

AIRPORTS

Procedures for Air Navigation Services; Aerodromes and Ground Aids (AGA). 3rd Ed. Montreal, Canada, International Civil Aviation Organization, 1947. 9 pp.

BIBLIOGRAPHY

United States Aviation Policy; A Selective Bibliography. Arthur G. Renstrom. (U.S., Library of Congress, Aeronautics Division.) Washington, 1947. 58 pp. (Mimeographed.) An annotated list of 400 of the significant publications dealing with problems that have arisen in the process of formulating a national air policy. It constitutes an expansion and revision of a series of bibliographies originally prepared at the request of the Congressional Aviation Policy Board and is divided into sections devoted to general materials pertaining to aviation policy, aircraft industry, air transportation, military and naval aviation, Government organization, and an author index.

ELECTRONICS

Radio Engineering. Frederick Emmons Terman. 3rd Ed. New York, McGraw-Hill Book Co., Inc., 1947. 969 pp., illus, diagrs. $7.00. This third edition of a standard work on radio engineering has been entirely rewritten to take into account the many advances that have occurred in the radio field during the past ten years. Increased attention has been given to ultra-high-frequency and microwave techniques, and also to the wide-band and pulse methods used in television and radar. There is a new chapter on circuits with distributed constants which summarizes the principal properties of transmission lines, wave guides, and cavity resonators. The material on electronic tubes has been expanded to include electron optics, transient-time effects, and new tubes, such as the reflex klystron, magnetron, and travelling-wave tube. The subject matter has been selected with the object of supplying the latest information on frequency modulation, television, pulse techniques, and the higher frequency parts of the spectrum. The subject index is detailed and there is a 57-page section of problems to be worked out by the student.

Electronic Circuits and Tubes. Cruft Laboratory, Electronics Training Staff, Harvard University. New York, McGraw-Hill Book Co., Inc., 1947. 948 pp., illus., diagrs. $7.50. A book on the basic theory of electronic tubes and the electrical circuits used with them. Particular emphasis is placed on applications in the fields of communications and electronic control. The volume has been developed from lecture notes of a special war training course given in the Graduate School of Engineering, Harvard University. Fundamental principles are clearly set forth, and the book contains much new material as well as new methods of presentation. For those who require preparation in the subjects discussed, helpful supplementary material on mathematics, electricity, and magnetism are supplied in appendixes. Some of the subjects dealt with include the theory of alternating currents, circuit response, circuit elements and their measurement, the various types of tubes, rectifiers and power supplies, signal analysis, the principles of modulation, test instruments, radio receivers, and timing circuits.

FLIGHT TESTING

Considérations sur la Conduite et l'Exploitation des Essais de Qualités de Vol des Avions (The Conduct and Use of Tests of the Flight Qualities of Airplanes). Maurice Cambois. (Les Essais en Aéronautique, Vol. 1.) Paris, Dunod, 1945. 126 pp., diagrs. 455 fr. This work is divided into two parts, the first dealing with methods of flight testing, the conduct of flight tests, and the handling of results obtained. The second part deals with theoretical justifications of concepts introduced in the discussion of actual flight testing. The treatment is systematic, taking up longitudinal and lateral stability, movable surfaces, and the engine group under each topic. The author, who is chief aeronautical engineer of the French Air Ministry, aims at a synthesis of theory and practice, taking both wind-tunnel testing and flight testing into account.

Cinématique de l'Avion (Photography of the Airplane). Francis Hussenot. (Les Essais en Aéronautique, Vol. 3.) Paris, Dunod, 1947. 81 pp., diagrs. 290 fr. Using a representation designated as the trihedral airplane, on which a fixed point corresponds to a fixed point on the airplane whose position in space is known, a method is outlined for the study of the dynamics of the airplane by mean of photography. The first part of the discussion takes up trigonometric relations, plane representation of the trihedral airplane, and geometric constructions. The translation of airplane movements into these is developed in chapters on movement of rotation and on the real movement of the airplane, then the particular cases of the permanent régime of flight, movement parallel to a fixed plane, and stabilized turning at a constant altitude are illustrated. Cameras for use on the ground and in the airplane, types of gyroscopes, pendulums, accelerometers, and apparatus for aerodynamic measurements are described. Several examples worked out from practice are given in conclusion.

LABORATORIES

Directory of Commerical and College Laboratories. (U.S., National Bureau of Standards, Miscellaneous Publication No. M187.) Washington, U.S. Govt. Printing Office, 1947. 65 pp. $0.30. A classified list of commercial testing and research laboratories located in the United States, with information about the commodities they are willing to test for commodity acceptance or other purposes. Particulars are given about 220 commercial laboratories, with 80 branches or offices. Also presented is a list of the laboratories of 189 colleges which are used not only for purposes of instruction but also for research and testing work.

MANAGEMENT

Principles of Industrial Organization. D. S. Kimball and D. S. Kimball, Jr. New York, McGraw-Hill Book Co., Inc., 1947. 531 pp., illus., diagrs., tables. $4.50. The sixth edition of a well-known book setting forth the fundamental principles of industrial management. The volume is based on a course of lectures given by the author to the senior class in Sibley College of Mechanical Engineering, Cornell University. While written primarily for the young engineer, much of the information will be of value to practicing engineers and managers.

MATHEMATICS

Calculus of Finite Differences. Charles Jordan. 2nd Ed. New York, Chelsea Publishing Company; 1947. 652 pp., figs. $5.50. A book written especially for the computer but one which may also be used as an introduction to the study of mathematical statistics and the calculus of probability. The author, who is Professor in the University of Technical and Economical Sciences of Budapest, has made a thorough study of literature on the calculus of finite differences which has appeared during the last two centuries. The book contains new methods that permit simplifications, and it should be of great value to statisticians.

Almost Periodic Functions. Harold Bohr. (Berlin, 1933.) New York, Chelsea Publishing Co., 1947. 114 pp., figs. $2.25. (Photooffset from typewritten copy.) A translation of a German treatise on the theory of almost periodic functions. The main features of the theory were developed by the authors and set forth in three articles published in *Acta Mathematica*. The book is confined to a discussion of functions of a real variable and continuous functions. Appendixes are devoted to the generalization of the theory and an account of periodic functions of a complex variable.

METALS & ALLOYS

Forming of Austenitic Chromium-Nickel Stainless Steels. Vsevolod N. Krivobok and George Sachs. New York, The International Nickel Co., Inc., 1947. 309 pp., diagrs. (Out of Print.) A detailed description of the modern forming procedures as applied to chrome-nickel steel in its various forms. Chapters are devoted to the mechanical properties of chromium-nickel stainless steels; forming characteristics of austenitic stainless steels; processing after forming; design, layout, and preparation of blanks; equipment, tools, and lubricants; bending and straight flanging; the forming of curved sections and tubing; forming of contoured-flanged parts; deep drawing of cup-shaped, box-shaped, and related parts; double-action die forming of deep- and shallow-recessed parts; forming of deep- and shallow-recessed parts by miscellaneous methods; forming of semi-tubular parts.

METEOROLOGY

Techniques of Observing the Weather. B. C. Haynes. New York, John Wiley and Sons, Inc. 1947. 272 pp., illus., diagrs. $4.00. This book has been prepared especially for high school and college courses in elementary meteorology, but will also be of value to the layman interested in weather observing. The text follows closely the various United States Weather Bureau instructions on observations. An extensive bibliography is included.

THERMODYNAMICS

Eléménts de Thermodynamique et Physico-Chimie de la Combustion dans les Moteurs (Elements of Thermodynamics and Physical Chemistry of Combustion in Engines). Max Serruys. Paris, Dunod, 1945. 106 pp., diagrs. 175 fr. The author aims to present the most recent methods of calculation which will be of use to the engineer, without employing higher mathematics. The material is based on a series of four lectures given at the Centre d'Études Supérieures des Ingénieurs to automobile engineers, which deal with the study of efficiency in the simplified hypothesis of the closed cycle and under real conditions of combustion, propagation of combustion, and combustion in Diesel engines.

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(*Continued from page 15*)

Austin; Student Council Representative (Jr.), D. J. Eddy. J. W. Keckler automatically became the Senior Student Council Representative.

The Honorary Chairman, S. M. Acton, and faculty members Q. J. Hawthorne, G. H. Fries and H. R. Wright were present.

University of Tulsa

"Aspects of Engine Design and Production" was the subject of a talk by Carl T. Doman, Chief Engineer, Aircooled Motors, Inc., at the November 6 meeting, William C. Burkitt, Chairman, presiding.

Mr. Doman spoke of the engineering aspects of air-cooled engines and illustrated his talk with slide pictures.

In addition, a film, *PBM-3 Wing Destruction Tests*, by The Glenn L. Martin Company was shown.

At the December 18 meeting, E. H. Cole, Engineering Inspector, C.A.A., Tulsa, gave a talk on "The Civil Aeronautics Authority and Its Application to Civil Aviation," and an N.A.C.A. film, *A Study of Airflow by Means of Smoke*, was shown.

News of Members

Arthur E. Bryson, Jr., was named Development Engineer, Container Corporation of America.

John A. Burt, formerly Stress Analyst, Helicopter Division, Bell Aircraft, is with Carborundum Company as Construction Engineer.

Norman W. Carey is Registered Professional Engineer in Illinois and Stress Analyst, Bartelt Engineering Company.

Myron L. Daggett, Jr., former engineer with Curtiss-Wright, now is Design Engineer with Chase Aircraft Company.

Subodh Chandra Das is with Pan American World Airways as a Trainee, Pacific-Alaska Division.

William C. Droege resigned from Northwest Airlines to become Heat Transfer Engineer with Smith, Hinchman & Grylls.

Marvin A. Evenchik is Manager, The Rigbee Company.

Joseph P. Fay, former Tool Engineer, Republic Aviation Corporation, is now Engineering Design Checker, Consolidated Vultee Aircraft Corporation.

Werner H. Geiger, Army veteran, is with American Overseas Airlines as Engineer.

Harry R. Gillespie is Research Engineer, Illinois Institute of Technology.

Arthur W. Gilmore was named Engineer on Research—Aerodynamic Heating Project—and Graduate Student, University of California.

Jerome M. Goldman is Flight Supervisor, Purdue University Airport.

Robert L. Goodin was named Engineer, Consolidated Vultee Aircraft Corporation.

John P. Gratiot, former M.I.T. student, is with De Florez Engineering Company as Engineer.

John F. Hawkins is Chief Draftsman, Frontier Aircraft Corporation. He resigned from Fleet Aircraft Ltd. (Canada) as Chief Draftsman to assume new position.

David Ingalls, former Chief Engineer with Titeflex, Inc., now is President, Airtron, Inc.

Zygmunt Jaros is Schedule and Administrative Engineer, American Machine & Foundry Company.

Floyd G. Keiter was named Senior Stress Analyst, McDonnell Aircraft Corporation.

William D. Laird has been appointed Assistant General Secretary, The Engineering Institute of Canada.

Emery E. Lothrop, former Sales Engineer, Curtiss-Wright Corporation, is Manager, Aviation Research Division, American Petroleum Industries Committee.

Wendell W. Lowry resigned from United Air Lines to become Engineer, Defiance Machine Works.

David E. Lukens is Director of Sales, Philadelphia Metal Warehouse Company, Aircraft Division.

Merven W. Mandel is Research Assistant, Polytechnic Institute of Brooklyn.

John E. McGinness, Jr., is Owner, McGinness Air Charter Service.

Robert V. Meghreblian, former Navy Ensign, is Engineer, Jet Propulsion Laboratory, California Institute of Technology.

Roy C. Muir retired from General Electric Company where he was Vice-President in charge of Engineering.

William B. Pepper, Jr., is Design Draftsman, Douglas Aircraft Company, Inc., El Segundo plant.

Richard J. Petrein, former Lieutenant, Army Air Forces, is Assistant in Department of Aeronautics, New York University.

Samuel T. Robinson, former Vice-President, Taylor Turbine Corporation, is with Sanderson & Porter.

Merle V. Ryan, Army Air Forces veteran, is with Boeing Aircraft Company as Design Engineer.

Donald K. Seulke, Navy veteran, is Engineering Draftsman, Lockheed Aircraft Corporation.

Ludwig M. Shusterich is the owner of Regional Engineering & Supply Company.

Irving A. Sofen resigned from Bell Aircraft Corporation to become Research Analyst "A," North American Aviation, Inc.

Theodore K. Steele is Instructor, Mechanical Engineering, New York University.

Wilfred H. Stuth is Engineer, McDonnel Aircraft Corporation.

Frederick B. Sutton resigned from Boeing Aircraft to become Aeronautical Research Scientist, N.A.C.A.

G. Stirling Thompson, formerly with Kaiser Fleetwings, Inc., now is owner of G. S. Thompson.

John D. Trimmer is Associate Professor of Physics, University of Tennessee.

Leonard Troy resigned as Vice-President, Metropolitan Oil Corporation, to become Fleet Supervisor, Metropolitan Convoy Corporation.

Ivan P. Villalba resigned from Grumnan Aircraft to become Senior Research Assistant, Polytechnic Institute of Brooklyn.

John E. Viscardi is Director of Research & Development, Bowen Engineering Corporation.

Ludolph F. Welanetz, former Professor of Mechanical Engineering, U.S. Naval Postgraduate School, is with Thiokol Corporation.

Robert Bruce White was appointed a Colonel, Chief, Maintenance & Engineering, U.S.A.F.

Adolph John Wittenbach is Flight Test Analyst, Consolidated Vultee Aircraft Corporation.

James W. Whittlesey is Assistant Mechanical Engineer, Natural Gasoline Department, Standard Oil Company of California.

Russell E. Wilshusen was named Assistant Scientist, University of Minnesota.

Harold W. Yerkes, Jr., resigned from Aeronca Aircraft Corporation, to become Production Engineer with Chase Aircraft Company.

Edmund G. Wodrich is Aerodynamics Engineer, Hughes Aircraft Company.

Leland R. Yager is a pilot with Liberty Flying Service, Inc.

Members Elected

The following applicants for membership or applicants for change of previous grades have been admitted since the publication of the list in the last issue of the REVIEW.

Transferred to Associate Fellow Grade

Haber, Bernard D., B.S. in Ae.E., Chief, Research Engineering Group, Structures Test Lab., Air Materiel Command (Wright Field).

Carah, Alfred Jean, M.E. in Ae.E., Interiors Engineer in Charge of Interiors Design Group, Douglas Aircraft Co., Inc.

Cook, Frank Richardson, B.S. in Ae.E., Col.—Chief, Research Div., Research & Development Directorate, Hq. General Staff, U.S. Air Forces.

Luskin, Harold, B.S. in Ae.E., Aerodynamics Research Engineer, Douglas Aircraft Co., Inc. (Santa Monica).

Elected to MEMBER Grade

Beers, Max Irvin, E.E., Project Engineer, Flight Control Equipment Group, Sperry Gyroscope Co., Inc.

Klein, Harold, M.S. in M.E., Aerodynamics Engineer, Douglas Aircraft Co., Inc.

Knerr, Horace C., President, Consulting Metallurgical Engineer, Metlab Company (Metallurgical Laboratories, Inc.).

Mirman, Jean, Ae.E., Consulting Engineer, self-employed.

Sanders, Newell Drake, M.S. in M.E., Chief, Experimental Analysis Panel, Wind Tunnel & Flight Div., Flight Propulsion Research Lab., N.A.C.A.

Sheppard, William Alan, M.S. in M.E., Lt. Col., Director New Developments Div., Air Tactical School (Fla.), U.S. Air Forces.

Versfeld, Ivan Henry, Fuel Technologist, Vacuum Oil Company of South Africa Ltd. (Cape Town, South Africa).

Transferred to MEMBER Grade

Bartlett, George Edgar, B.S. in Ae.E., Research Aerodynamicist & Section Head, Cornell Aeronautical Lab.

Brown, Sherwood Hulett, M.S. in Ae.E., Aerodynamicist A, Northrop Aircraft, Inc.

Bugielski, William Zygmunt, B.S. in Ae.E., Vibrations Engineer, Bell Aircraft Corp.

Burghardt, Joseph Endler, M.E., Group Aerodynamicist, The Glenn L. Martin Co.

Dietrich, Fred H., B.S. in Ae.E., 1st Lt., Aerodynamics Test Engineer, Flight Research Section of Flight Test Div., U.S. Air Force.

Elliott, Roger Douglass, B.S. in Ae.E., Aerodynamicist, Northrop-Hendy Co.

Fleming, William Adam, B.S. in Ae.E., Head, Section "A," Flight Propulsion Research Lab., N.A.C.A.

Fuller, George Milton, Jr., B.S. in Ae.E., Instructor in Theoretical & Applied Mechanics, Iowa State College, and Graduate Student in Aero. Engineering.

Geelan, George Guenther, B.Ae.E., Research Engineer & Designer, Cornell Aero. Lab.

Huppert, Merle Cecil, B.S. in M.E., Project Engineer P-4, Turbine Design & Turbo Prop, Engine Analysis Flight Research Lab., N.A.C.A.

Kroupa, Charles Emil, B.Ae.E., Asst. Aerodynamicist, Guided Missile Group, Grumman Aircraft Engineering Corp.

Murray, Harry Ernest, B.S. in Ae.E., Aero. Engineer P-4, Langley Mem. Aero. Lab., N.A.C.A.

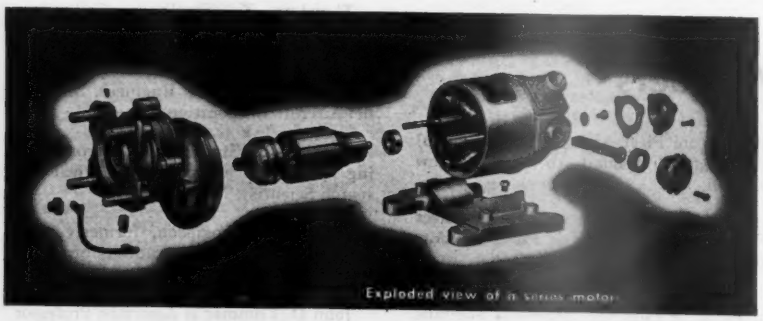
Pearce, Rufus Burleson, Jr., M.S. in Ae.E., Research Engineer A, Supersonic Wind Tunnel, North American Aviation, Inc.

Reesing, Harlan Allen, B.S. in Ae.E., Class "B" Designer, El Segundo Div., Douglas Aircraft Co., Inc.

Rothchild, Oscar Abraham, B.S. in Ae.E., Research and Development Engineer Rosenthal Manufacturing Co.

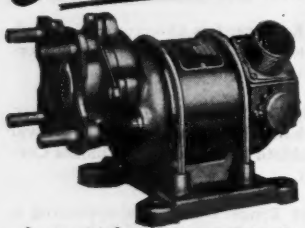
Shields, Edward Beverly, Jr., M.S. in Ae.E., Engineering Designer "B," Boeing Aircraft Co.

Smith, James Vincent, B.Ae.E., Technical Service Engineer, Stratos Corp.


Exploded view of a series motor.

EVERY PART ENGINEERED FOR THOROUGH DEPENDABILITY . . .

Lamb Electric MOTORS


Base-mounted, explosion-proof aircraft geared fuel transfer pump motor.

Rugged construction is a major factor in the reliability of this motor widely used in the field of mechanized equipment.

Careful designing and manufacturing backed by rigid testing assure thorough dependability of every part in a Lamb Electric Motor and result in satisfactory performance.

Because of this standard of dependability and performance, Lamb Electric Motors are being teamed up with more and more of America's finest products.

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Lamb Electric
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Spangler, Theodore Allen, B.S. in M.E. (Aero.), Aerodynamicist, Aerodynamics Unit, Boeing Aircraft Co.

Spryer, Edward Neal, Jr., B.S. in M.E. (Aero), Sr. Structures Engineer, Loads Group, Airplane Div., Curtiss-Wright Corp.

Tinsley, Walton Eugene, M.Ae.E., Systems Engineer, Flight Test Dept., NAMTC (Pt. Mugu, Calif.), Pilotless Plane Div., Fairchild Engine & Airplane Corp.

Toumanoff, George Irakly, B.S. in Ae.E., Sr. Research Engineer, Aerodynamic Research Projects, Republic Aviation Corp.

Tsu, Jack Chang-Nee, M.S. in Ae.E., Aerodynamicist, Northrop Aircraft, Inc.

Ward, Arnold Carlyle, B.S. in Ae.E., Stress Analyst, Ft. Worth Div., Consolidated Vultee Aircraft Corp.

Zell, John Hurster, M.S. in Ae.E., Aero. Engineer, Chief, Aircraft Analysis Section, Air Materiel Command (Wright Field).

Young, Raymond Arthur, B.S. in Ae.E., Aero. Engineer P-4, Design Elements Div., Bureau of Aeronautics, Navy Dept.

Elected to Associate Member Grade

Antonios, Anthony, Instructor, Aviation Mechanics, Manhattan High School Board of Education (New York City).

Hawthorne, Randolph, News Editor, AERONAUTICAL ENGINEERING REVIEW, Institute of the Aeronautical Sciences, Inc.

Transferred to Associate Member Grade

Hoffman, Willard Albert, Project Engineer, Test & Evaluation Div., NAMTC (Pt. Mugu, Calif.).

Mutch, Marvin Howard, Design Engineer—Jr., Electrical & Radio Installations, Wichita Div., Boeing Airplane Co.

Nolan, James Robert, Product Development Engineer, Hobbs Mfg. Co.

Elected to Technical Member Grade

Achitoff, Louis, A.M. (Chemistry, Engineering Pilot, Colonial Airlines, Inc.

Martin, George P., B.S.Ae., Instructor, Aeronautical Engineering Dept., Lawrence Institute of Technology.

Meerbaum, Sam, M.S. in M.E., Research Engineer, Special Projects Dept., M. W. Kellogg Co.

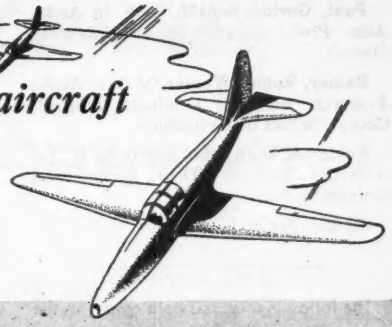
Transferred from Student to Technical Member

Hepler, Andrew Karl, B.S. in Ae.E., Engineer, Boeing Aircraft Co.

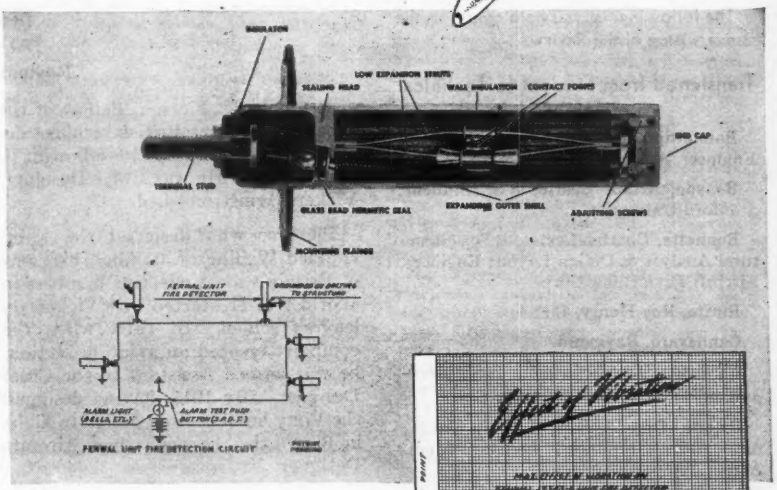
Jahn, Charles Frederick, B.S., Sr. Detailer, McDonnell Aircraft Corp.

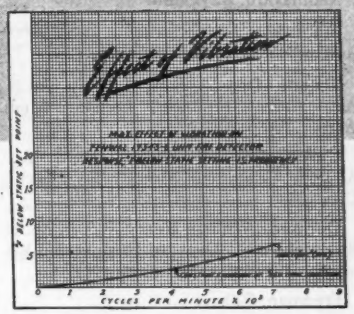
Kovarick, Frank Lutter, B.S., Aircraft Components Tester, Ranger Aircraft Engines Div., Fairchild Engine & Airplane Corp.

Mooers, Alden John, M.S.Ae., Aerodynamicist, Ordnance Research No. One, University of Chicago.



FIRE *in an aircraft reported in less than 3 seconds*





Thermoswitch* Unit Fire Detector gives positive protection under all flight conditions.

Located at all vital "hot spots" in a unique single loop circuit, THERMOSWITCH* Unit Fire Detectors respond within three seconds to fire, flashing a signal on the instrument panel to indicate the zone of fire.

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Aircraft Fire Detectors

SENSITIVE . . . *but only to heat*

Pant, Govind Ballabh, M.S. in Ae.E., Asst. Prof., Benares Hindu University (India).

Rainey, Robert Weaver, M.S. in Ae.E., Research Asst. & Graduate Student, Georgia School of Technology.

Robinson, Allan John, B.S. in Ae.E., Instructor in Structures Dept., Aeronautical University, Inc.

Snyder, James L., Ae.E.

The following list was held over from the January issue of the *Review*.

Transferred from Student to Technical Member

Baudettini, Angelo, B.S. in Ae.E., Aero. Engineer, Ames Aero. Lab., N.A.C.A.

Benson, Arthur Searle, B.S., Student, Stanford University.

Bonnette, Charles Lester, B.Sc., Structural Analyst & Design Layout Engineer, Aircraft Div., Globe Corp.

Burita, Roy Henry, B.S.

Cannavaro, Raymond.

Carnese, Daniel Joseph, B.S., Aerodynamicist, Piasecki Helicopter Corp.

Coletti, Donald Earl, B.S. in Ae.E.; Aeronautical Engineer, Langley Mem. Aero. Lab., N.A.C.A.

Curtis, Edward Joseph, Flight Test Analyst, Grumman Aircraft Engineering Co.

Dorrance, William Henry, B.S. in Ae.E., Research Asst., Dept. of Engineering Research, University of Michigan.

Freeman, Robert S., B.Ae.E.

Gollos, Warren William, B.S.Ae.

Hansen, Jerry Anton, Jr., B.S. in Ae.E., Jr. Engineer, Babcock & Wilcox Co.

Hobe, Audrey Ann, Miss, B.S. in M.E., Mech. Engineer (Development Dept.), U.S. Rubber Co.

Jablecki, Leon Stanyslau, B.S. in C.E., Major, Chief—Aircraft Structures Unit, U.S. Air Forces.

JogaRao, Chintakindi Venkata, B.Sc. in M.E., Graduate Student, California Institute of Technology.

Le Clair, Richard Douglas, B.S. in Ae.E., Graduate Student, University of Michigan.

Miller, Jack Naylor, M.S. in Ae.E., Lt., U.S. Navy.

Morse, Robert Charles.

Oberfell, Robert Hutchisson, B.S. in Ae.E., Mech. Engineer, Carter Oil Co.

Painter, Norman Joseph, B.S., Technical Calculator, McDonnell Aircraft Corp.

Passman, Richard A., B.S.E. (Math.), Aerodynamicist, Bell Aircraft Corp.

Prentice, Robert Joseph, B.S. in Ae.E., Draftsman & Engineer, Engineering Dept., Foote Bros. Gear & Machine Corp.

Reiter, Sydney Howard, B.S. in Ae.E., Research Engineer, University of Southern California (in their Navy Research Project on jet engines).

Rhoads, Donald Wolf, B.S. in Ae.E., Engineer, Cornell Aero. Lab.

Shorkey, Irving Alonzo.

Spruill, Cecil Ernest, B.S. in Ae.E., Graduate Student, Virginia Polytechnic Institute.

Spuhler, Edwin Henry, B.S. in Ae.E., Sales Engineer Trainee, Aluminum Co. of America.

Wagner, Robert William.

Willhoft, Earl Curtis, Jr. Research Engineer, Chrysler Corp.

Zoellner, Robert, Engineering Dept., Republic Aviation Corp.

Necrology

Reginald K. Pierson

Reginald K. Pierson, Fellow of the Institute, pioneer British airplane designer, died January 10 following a long illness. He was Chief Designer, Vickers-Armstrong Ltd.

Pierson, who designed the twin-engined Wellington bomber, long one of Britain's most effective bombers in World War II, started with Vickers on leaving school. In 1910, when the company created an aviation section, he was named Assistant to the Chief Designer. By 1917, having designed the Vimy bomber from design to flight in 6 months, he was Chief Aircraft Designer.

One of his aircraft, a modification of the Vimy bomber, was flown by Alcock and Brown in the first nonstop flight across the Atlantic in 1919. Pierson also developed the Vespa and Wellesley aircraft of metal construction, as opposed to wooden construction prevailing at the time, and the Warwick, used as a transport and cargo plane in many war theaters.

Both the Wellington and Warwick were of geodetic construction, which combined great strength with low structural weight, permitting range and load-carrying performance previously thought unattainable.

In 1934, Pierson spent a month in the United States studying conditions in commercial aviation.

Born on February 9, 1891, he received a pilot's certificate in 1913. He was a Fellow of the Royal Aeronautical Society and an Associate Member of the Institution of Civil Engineers.

Changes of Address

Since the Post Office Department does not as a rule forward magazines to forwarding addresses, it is important that the Institute be notified of changes in address 30 days in advance of publishing date to ensure receipt of every issue of the *Journal* and *Review*.

Notices should be sent directly to:
Institute of the Aeronautical Sciences
2 East 64th Street,
New York 21, N.Y.

Personnel Opportunities

This section is for the use of individual members of the Institute seeking new connections and organizations offering employment to aeronautical specialists. Any member or organization may have requirements listed without charge by writing to the Secretary of the Institute.

WANTED

Aerodynamicists, Thermodynamicists, Stress Analysts, Aircraft Designers—North American's engineering program offers a number of excellent openings in the classifications above for qualified engineers. Salaries commensurate with training and experience. Please include complete details in reply. Engineering Personnel Office, North American Aviation, Inc., Municipal Airport, Los Angeles 45, Calif.

Helicopter Aerodynamicist—Experienced, required for long-term development program for U.S. Air Force. Apply in writing to Manager, Helicopter Division, Kellett Aircraft Corporation, North Wales, Pa.

Aerodynamicists—With experience in stability and control work and flight testing. Positions require good academic background and sound knowledge of dynamics and applied mathematics. Advanced degree desirable. Must have training, experience, and ability to assume major responsibility in both the theoretical and experimental flight-test phases of major programs of aircraft flight dynamics, and be familiar with standard methods of flight-data reduction. Write Employment Office, Cornell Aeronautical Laboratory, 4455 Genesee St., Buffalo 21, N.Y.

Research Engineers—Openings for experienced aerodynamicists, thermodynamicists, and electronic engineers with opportunity for research in supersonics. Openings also for engineers with jet-engine-test experience. Please include complete résumé of experience and education in reply. Write to: Consolidated Vultee Aircraft Corporation, Lone Star Laboratory, Daingerfield, Tex.

Aeronautical Engineers—Aircraft research engineers and scientists needed for work on task research programs. Projects under way require men with the ability to apply the theories of dynamics, structures, aerodynamics, thermodynamics, and aircraft design to the solution of varied applied research problems on airplanes, helicopters, and guided missiles. Education background and knowledge should approximate that required for a Masters Degree in Engineering or Physics. Experience desirable but not so essential as a good basic training and a well-developed scientific curiosity. Cornell Aeronautical Laboratory, Employment Office, 4455 Genesee St., Buffalo 21, N.Y.

Assistant Professor or Instructor—Staff member to teach aircraft structural analysis and applied mechanics; also to set up complete structural testing laboratory. Must be familiar with aircraft structural practices in order to work with local aircraft industry. Previous teaching experience desired but not essential. Please give brief sketch of education, experience, and personal qualifications. Address, Kenneth Razak, Head of Aeronautical Engineering Department, University of Wichita, Wichita, Kan.

Mechanical Engineer—An excellent opportunity is open for a mechanical engineer with experience in gas turbines. You will have the best of laboratory equipment to work with and an opportunity for freedom of expression and development of ideas with the leading manufacturer of automatic control equipment. Write today giving full particulars of your training and experience: J. A. Johnson, Minneapolis-Honeywell Regulator Company, 4th Ave. and 28th St., Minneapolis 8, Minn.

Flutter Engineer—Aeronautical Engineering graduate with several years of experience in flutter and vibration problems for work on advanced military aircraft. Address reply to Engineering Personnel Office, North American Aviation, Inc., Municipal Airport, Los Angeles, Calif.

834. Helicopter Pilot—Experienced helicopter pilot with over 150 hours' helicopter time. Commercial operator desires chief pilot to take charge of operations.

832. Mechanical Designer—Instrument field, Long Island area. Must be capable of handling complete design of small, precision mechanical computers involving numerous automatic inputs.

830. Engineer—High calibre; flight-test operations experience necessary; pilot experience desirable. Must be graduate engineer. East Coast.

823. Pilots—Experienced helicopter test pilots wanted. Must have a minimum of 100 hours of helicopter flying time. Engineering background desirable. Preferably service trained. East Coast concern.

812. Engineer—Production—Trained in designing for low-cost production. Must be a graduate engineer and have aircraft experience. Progressive and expanding concern in metropolitan Philadelphia area. Send complete résumé.

811. Engineer, Mechanical—Experienced in the designing of precision transmission systems. Aircraft experience preferred. Progressive and expanding concern in metropolitan Philadelphia area. Send complete résumé.

810. Engineer—Qualified aeronautical or mechanical engineer with a minimum of 4 years' experience in the helicopter field. Progressive and expanding concern in metropolitan Philadelphia area. Send complete résumé.

804. Theoretical Aerodynamicist—A Ph.D. in Aeronautical Engineering, Mathematics, or Physics is needed at a large Mid-Western university as an associate professor or professor in the Department of Aeronautical Engineering to teach advanced theoretical courses in aerodynamics. The duties would include advanced undergraduate and graduate teaching through the Ph.D. level and the direction of theses. Opportunities for research, research consultation, and industrial consultation exist.

The number preceding the notices represents the Box Number of the Institute of the Aeronautical Sciences to which inquiries should be addressed.

AVAILABLE

843. Airline Engineering Executive—Graduate engineer, age 41. Nineteen years' all-round experience in air-line engineering and maintenance including 6 years' experience as factory representative developing new aircraft. Desires new contact with expanding possibilities.

842. Associate Professor—Associate Professor of Aeronautical Engineering, Doctor of Aeronautical Engineering, seeks change of position. Possesses engineering as well as mathematics advanced degrees. Major field: theoretical aerodynamics and gas dynamics.

841. Aeronautical Engineer—Structures engineer desires change. B.Ae., N.Y.U., 1942. Four years' experience in aircraft structural design, including research in thick skin and sandwich construction. Prefers position in business associated with aircraft field work or sales. Open to any interesting offer affording possibilities for a good future.

840. Aeronautical Engineer—M. Aero. Eng.; age 33. Ten years' experience in flight-test and operational engineering, air-line operations, sales and market research, and technical writing. Wide contacts in air transport and manufacturing fields. Desires position as assistant to executive, or sales engineer, in New York or New England area.

839. Helicopter Engineer—Chief designer and project engineer on two helicopters. Author of book on helicopter design. Five and one-half years of helicopter experience. Available immediately.

838. Aeronautical Engineer—B.S. in M.E., B.S. and M.S. in Ae.E.; age 46, married. Professional engineer with seal. Ten years of structural design and analysis as per Army, Navy and C.A.A. specifications. Two years of engineering methods standardization. All with major aircraft companies. Desires responsible position in aircraft or related field.

837. Aeronautical Structural Engineer—Graduate engineer with 20 years' experience in all phases of aircraft structural design on fixed and rotary wing aircraft. For past 10 years has held position of chief structural engineer with well-known manufacturer of military airplanes. Had complete responsibility for structural analysis, vibration and flutter, structural testing, and weight control. Desires connection with established organization in which his background and experience can be used to advantage.

836. Aeronautical Engineer—B. of Ae., New York University, 1944. During last year engaged in research in supersonics in a large research organization; has knowledge of several foreign languages. Presently employed, but desires change to a position in engineering or research department in firm located in New York City or vicinity.

835. Development Engineer—Wide plastics structures background. Has had positions of design engineer, test engineer, chief test engineer, and assistant chief engineer with medium-sized Eastern aircraft firms. Used to responsibility and difficult problems. Desires position with

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Aircraft Fork AN 667
Aircraft Turnbuckle Sleeve AN 669
Aircraft Ball
Aircraft Ball and Shank
Aircraft Threaded Sleeve AN 666

SWAGED TERMINALS are your lightest, most compact attachments for aircraft controls—and give you full catalog strength of the cord. Besides that, assemblies of Roebling Swaged Terminals and Roebling Aircord—cord with almost no constructional stretch—practically eliminate the need for repeated adjustments.

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company doing research and development work, especially in the design and construction of large reinforced plastic structures for aircraft or allied fields.

833. Research and Development Engineer—Physicist and aeronautical engineer; age 37. M.S. in Aeronautical Engineering, California Institute of Technology. D.Sc. in Physics; Fellow, Institute of Physics, London. Willing to accept suitable position in research institution, university, or in the research and development division of large industrial concern engaged in aeronautical or allied activity. Twelve years' overall experience in physical research and aeronautical engineering. Author of a number of papers and reports on several branches of physics and aeronautics. Considerable aptitude for invention. U.S. patent for aeroplane C. G. Calculator pending. Formerly held responsible position in U.S. aircraft concern. Excellent references in U.S. and India.

831. Engineer—Ten years' experience in metallurgy, process engineering, structural analysis and testing. Desires position in production, research, or development field with air-line, airframe, or accessory manufacturer.

828. Aeronautical Engineer—B.S. Ae.E.; age 29; married. Five years' experience, including performance estimation, stability and control analysis, aeronautical research and wind-tunnel testing, and stress analysis on military and commercial aircraft. Familiar with C.A.A. requirements. Desires permanent position in above or related fields, preferably on West Coast.

827. Mechanical or Aeronautical Engineer—M.S. Desires position that combines engineering or research with administrative duties; East Coast, preferably New England. Last 4 years as aerodynamicist, designer, and development engineer on guided missiles projects; previous experience includes 8 years of extensive research, consulting work, and teaching at leading Eastern engineering school. Details and references upon request.

826. Aeronautical Engineer—M.S. in Ae.E. Over 4 years' experience with major aircraft companies, mainly in flutter and vibration work.

825. Quality Control Executive—Experienced in organizing and administering mechanical inspection and maintenance of aircraft and motor vehicles, recruiting and job evaluation for over 500 civilian office and technical personnel. Qualified airplane pilot—5,873 military hours, all types. West Point graduate, 1923. . Aeronautical engineer.

824. Associate Professor—B.S., M.S., receives Dr. Eng. (Aero.) in June, 1948. Broad experience includes: 5 years' graduate work and structural research; 4½ years in industry as stress analyst and structural test engineer; 4 years as assistant professor of aeronautical engineering teaching most of the undergraduate work in established department. Desires academic position handling senior and graduate courses (and related research) in aeronautical engineering or applied mechanics. Available in June.

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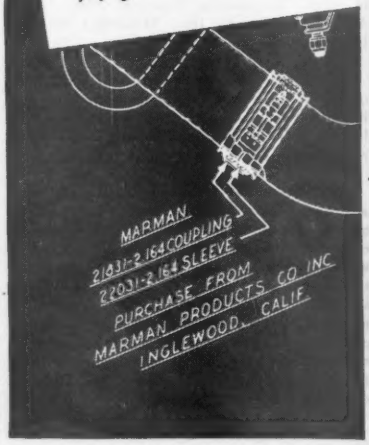

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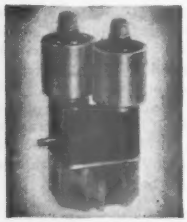

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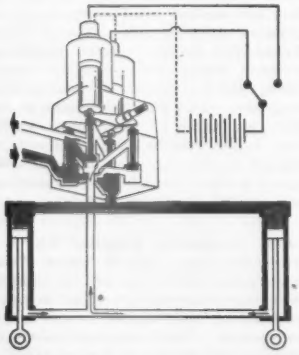

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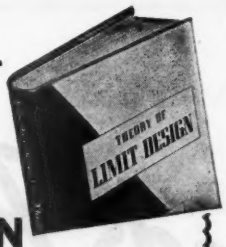

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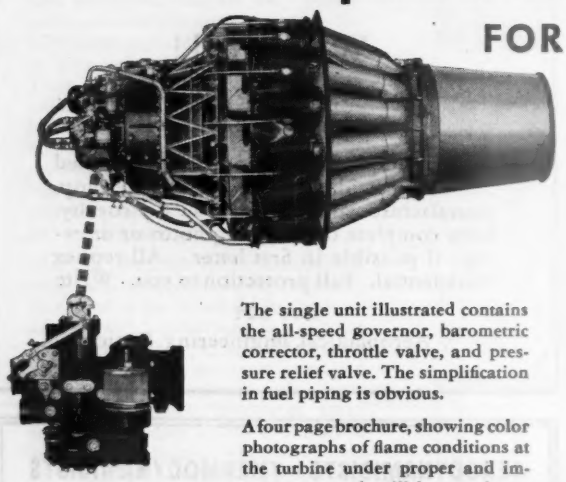

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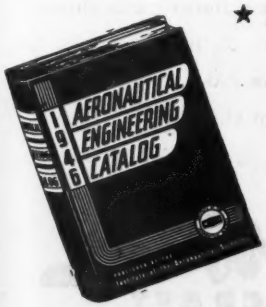

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